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The Effects of Trigger Point Dry Needling on Neck Pain in Adults: A Review

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Honors College, Western Washington University

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While estimates vary, many place the number of individuals worldwide that suffer from neck pain at over 220 million, with the condition being experienced more commonly by women (Safiri et al., 2020; World Health Organization [WHO], 2022). Not only does this pain impact the daily lives of these individuals, but it also poses a significant economic and productivity threat to broader society when these issues are left untreated (WHO, 2022). For example, in 2013, the United States alone spent over $87 billion on healthcare related to neck and low back pain (Dieleman et al., 2017).

One treatment method to reduce neck pain intensity involves releasing myofascial trigger points (MTrPs). Although specific definitions vary, the most commonly cited definition of an MTrP was established by Simons and colleagues in 1999. In the second edition of their foundational book for myofascial pain treatment, a trigger point is defined as “a hyperirritable spot in a taut band of skeletal muscle that is painful upon compression, stretch, overload, or contraction of the tissue” (Simons et al., 1999, as cited in Donnelly et al., 2019, p. 60). Trigger points can be categorized as either active or latent. Active trigger points are characterized by the spontaneous production of pain, whereas latent trigger points only produce pain when compressed or palpated (Travell et al., 1999, as cited in Donnelly et al., 2019).

Researchers have studied various methods to reduce pain by releasing MTrPs. Many of these methods, including injection, manual compression, exercise, and dry needling, have been shown to be effective and are used in clinical practice. Dry needling involves the palpation of a trigger point, targeted insertion of a thin needle into the skin, careful movement of the needle within the muscle, and subsequent retraction, with the goal of releasing the trigger point (Donnelly et al., 2019). Although guidelines for effective dry needling procedures exist, several

aspects of the procedure are not consistently agreed upon. These include the number of needle insertions that should be done on a trigger point, the necessity of eliciting a local twitch response, and the number of trigger points in a certain area that should be released (Donnelly et al., 2019).

The purpose of this review is to summarize the current literature on dry needling in order to assess its efficacy as a treatment method for neck pain in adult populations. The studies cited in this review represent a range of methodologies, with multiple researchers tracking some of these procedural factors along with outcome measures. While methodologies differed among the studies reviewed, differences in procedure were fairly minimal, with 14 out of 19 studies directly citing the technique used by Hong in 1994 in a foundational study on trigger point dry needling.

In Hong's study, patients were evaluated by the researcher, who then administered the treatments to the experimental groups. During the dry needling, the researcher would insert the needle through the skin, then inform the patient that they might experience some pain, discomfort, and/or muscle action during the procedure. The needle was then moved in what the researcher described as a "fast in … fast out" method, in which it is repeatedly inserted deeper into the tissue and then retracted, all while staying in the same area and without removing the needle from the skin. Once local twitch responses elicited by the needling stopped, the needle was removed from the skin (Hong, 1994, p. 258). Although there is still no definitive consensus on whether local twitch responses are necessary for pain relief, as was found in this study, the overall procedure is widely cited (Hong, 1994).

Multiple outcome measures are commonly tracked to assess the effectiveness of dry needling. In the studies cited in this review, the use of questionnaires and scales was common in order to represent subjective experiences (e.g., pain, disability, etc.) quantitatively to allow for statistical comparison. Subjective measures of neck pain are commonly assessed with

questionnaires, the most frequently used of which is the visual analog scale (VAS). Other common secondary outcome measures include pressure pain threshold (PPT), range of motion (ROM), and active range of motion (AROM), which are all quantitative measures as well.

Although dry needling has been studied since its introduction in 1979, studies do not consistently reach the same conclusions (Lewit, 1979). Some researchers have found dry needling to be significantly more effective than other treatment approaches, some have found it to be equally as effective, and some have found it to be just as effective as a sham treatment. Studies in each of these categories, potential explanations for their differing findings, and overall findings that can be extracted from the studies as a whole will be described below.

Trigger Point Dry Needling as an Effective Treatment Approach

Pain Intensity and Pressure Pain Threshold

Researchers in multiple studies that are reviewed below found dry needling to be effective in reducing neck pain and improving other associated symptoms. For example, Mejuto-Vázquez and colleagues (2014) conducted a study on the short-term effects of trigger point dry needling. Patients with neck pain (n=17, mean age: 25, 9 female, 8 male) were separated into two groups: the control group (n=8) received no treatment, and the experimental group (n=9) received one session of dry needling in an active trigger point in the upper trapezius. Researchers found significantly greater improvements in pain intensity scores and pain pressure threshold in the experimental group when compared to the control group at follow-up measurements 10 minutes and one-week post treatment (Mejuto-Vázquez, 2014). Other researchers have reported similar findings with respect to the effect of dry needling on pain intensity and pressure pain threshold in patients with one or more trigger points in the upper trapezius muscle resulting in pain (e.g., Hakim et al., 2019; Valiente-Castrillo et al., 2021). This was true even with varying

numbers of needling sessions. For example, Valiente-Castrillo and colleagues (2021) found improvements in pain after six sessions, while Hakim and colleagues (2019) reported improvements in both pain and PPT after only three sessions.

While the results of the studies mentioned above illustrate the short-term benefits of dry needling, other research suggests that these benefits exist long-term as well. For example, Martín-Sacristán and colleagues (2022) found dry needling in the upper trapezius to be effective in reducing neck pain in adults. Participants (n=65, 35 female, 30 male) were split into a control group (n=21), which received needling in an area without a trigger point, an experimental group which received dry needling in latent trigger points (n=22), and a second experimental group which received dry needling in active trigger points (n=22). Needling in all groups was performed with 12 insertions. Participants underwent one treatment session. At nine follow-up measurement times between the intervention and the final measurement taken one month after the treatment, participants were asked to rate their neck pain on a VAS. The results of the study suggest that dry needling in all locations was effective in decreasing pain (Martín-Sacristán et al., 2022). These results supported the findings of a similar study that compared dry needling on an active trigger point to dry needling done just 1.5 cm outside of one. Researchers found that the trigger point group (n=36) reported significantly less intense pain at both follow-up measurements (one week and one month) when compared to the control group (n=36). Additionally, while both groups showed improved pressure pain threshold when compared to baseline at follow-up measurements, the differences in the experimental group were significantly greater (Pecos-Martín et al., 2015). Taken together, these studies suggest that trigger point dry needling is an effective method to reduce neck pain and improve pressure pain threshold, both short- and long-term.

Trigger point dry needling has also been found to be more effective at reducing pain than other common treatments. For example, Cerezo-Téllez and colleagues (2016b) found dry needling and passive stretching in the trapezius to be significantly more effective than passive stretching alone at decreasing neck pain and improving PPT. Similarly, in a study on 30 patients with neck pain, Arias-Buría and colleagues (2020b) found that pain reduction was significantly greater one month after treatment in patients who had received dry needling in the scalene muscles compared to patients who had trigger points released with manual pressure.

Range of Motion

In addition to variables measured to specifically assess pain, range of motion is commonly measured to determine the efficacy of dry needling, as neck pain is often accompanied by a limited range of motion (University of Maryland Medical Center, n.d.). In the study by Mejuto-Vázquez and colleagues (2014) cited above, in addition to improvements in pain and PPT, researchers also found that the dry needling group had statistically significantly greater increases in range of motion at follow-up measurements taken 10 minutes and one week after needling when compared to those that did not receive treatment. While Mejuto-Vázquez and colleagues (2014) found a beneficial effect on range of motion short-term (minutes to weeks post-treatment), other researchers have found this to be the case long-term (one to six months post-treatment) as well.

For example, Hakim and colleagues (2019) found two different methods of trigger point dry needling to be effective in increasing range of motion in participants with chronic neck pain (n=26). During treatment, one group had trigger points in the upper trapezius needled until local twitch responses stopped, then had the needles left in for five minutes. The second group had the needles slowly inserted into the trigger points, where they were then left for five minutes without

eliciting a local twitch response. All participants received three sessions of treatment. The measurements taken four weeks after treatment not only suggest that dry needling is effective at improving range of motion but also provide evidence to suggest that dry needling without causing a local twitch response is more effective (Hakim et al., 2019). The finding that needling without eliciting a local twitch response is more effective was true of pain and PPT measurements along with range of motion as measured by lateral flexion tests (Hakim et al., 2019).

In another study, Cerezo-Téllez and colleagues (2016b) compared passive stretching to deep dry needling and passive stretching. In the study, 128 participants with neck pain were separated into groups that received up to four sessions of either dry needling in all trigger points in the upper trapezius and passive stretching (n=64) or only passive stretching (n=64). Measurements were taken at baseline and at six follow-up times over a six-month period. Researchers found both a larger improvement in active range of motion (AROM) and overall greater active ranges of motion in the group receiving dry needling. In fact, there was no statistically significant change found in the AROM of the passive stretching group at any follow-up measurement. The significant increases in AROM noted in the dry needling group were found consistently from the second measurement (following the second treatment session) until the final measurement taken six months after the first treatment session (Cerezo-Téllez, 2016b). Collectively, the results of these studies illustrate the positive effect of dry needling on short- and long-term improvements in range of motion.

Less-Studied Positive Outcomes

Although pain intensity, pressure pain threshold, and range of motion are often the primary variable of interest, researchers include other secondary variables as well. While these

are worth mentioning because they expand the scope of potential benefits to dry needling, more research is needed in order to draw more generalized and well-supported conclusions.

For example, Tsai and colleagues (2010) found remote trigger point dry needling to be effective in reducing trigger point sensitivity in another part of the body. Although this study was focused on shoulder pain, the muscle group studied is consistent with studies focused on neck pain, and very few other studies reported findings on this phenomenon, making it worth discussing in this review. In the study, one group of participants (n=17) received one session of dry needling in a trigger point in the extensor carpi radialis until local twitch responses ceased. The other group (n=18) received one session of sham needling where the needle was inserted into the skin but not deep enough to reach muscle tissue. Researchers then measured pain intensity and pressure pain threshold in the upper trapezius. The group that received dry needling was found to have significantly decreased pain post-treatment, and the sham needling group showed no significant improvement. In addition, the experimental group had significantly improved cervical range of motion post-treatment, while the control group showed no significant change. These findings indicate that dry needling could be an effective pain management technique, not only when the trigger points themselves are needled but also when needling is performed in trigger points in remote areas (Tsai et al., 2010).

Additionally, in the study by Arias-Buría and colleagues (2020b) described above, researchers compared the effects of dry needling and manual pressure release on inspiratory capacity, which the researchers define as “the maximum amount of air that can be inhaled after a full expiration” (Arias-Buría et al., 2020b, p. 382). Decreased inspiratory capacity values represent respiratory dysfunction (Arias-Buría et al., 2020b). Researchers measured baseline inspiratory capacity as well as one day, one week, and one month following treatment and found

a significantly greater increase in inspiratory capacity in the dry needling group than in the manual pressure release group (Arias-Buría et al., 2020b).

A final example of a less frequently studied outcome measure is a study that used a technique known as elastography to quantify changes in muscle stiffness after dry needling (Maher et al., 2013). Researchers found that dry needling was effective in reducing stiffness as measured by elastography when post-treatment measurements were compared to those taken before needling. Also noteworthy is the finding that this technology could be used to objectively determine the efficacy of the treatment because it presents a potential alternative to the commonly used subjective questionnaires. More research is required, however, due to the small sample size (n=7) and the fact that the sample only consisted of female participants (Maher et al., 2013).

Dry Needling in Combination with Other Treatments

Dry needling has also been found to be effective when used in conjunction with other treatment approaches. For example, in a study cited above, dry needling and passive stretching was found to be more effective than passive stretching alone both in terms of pain reduction and range of motion improvement (Cerezo-Téllez et al., 2016b). These findings were consistent with another study conducted by Cerezo-Téllez and colleagues (2016a) on 44 office workers with neck pain that followed a very similar procedure. Neither study included a group that received dry needling alone without stretching, making it impossible to determine whether the combination of treatments is most effective, but the studies both provide strong evidence that dry needling can be used with passive stretching to increase improvement (Cerezo-Téllez et al., 2016a, 2016b).

A second example of this is a study in which Valiente-Castrillo and colleagues (2021) examined the use of dry needling in combination with education in pain management. Participants in the experiment (n=60) were separated into three groups: one control group (n=19), which received standard care for chronic neck pain (10 electrotherapy sessions), a treatment group that received only dry needling in the main posterior neck muscles (n=20), and a second treatment group that received both dry needling (in the same location as the previous group) and pain education (n=21). The pain neuroscience education consisted of three 30-minute-long informative sessions on chronic pain and coping strategies. At all follow-up measurements, the dry needling and education group was found to have a greater proportion of patients whose reduction in pain exceeded the minimal value for clinically important difference than the control group. However, the only significant difference in pain decrease was found between both dry needling groups and the control group immediately following treatment. Because there was no significant difference in pain improvement reported between the two dry needling groups, the researchers did not postulate as to why pain education might enhance treatment effects. Researchers did, however, report improvement in various psychological factors, including fear of movement, pain anxiety, and general pain attitudes in the group that received pain education and indicated a need for more extensive research (Valiente-Castrillo et al., 2021).

Limitations to Studies in Support of Dry Needling

In an examination of the current literature in support of trigger point dry needling as a treatment for neck pain, it is important to note the limitations of the studies. First, in all of the studies cited above, participants were either young adults or middle-aged adults, leaving a lack of information on the effects of this treatment on younger and older populations. Additionally,

while many of the studies had sample sizes of fewer than 100, some have especially small sample sizes (e.g., Hakim et al., 2019; Maher et al., 2013; Mejuto-Vázquez et al., 2014). Although many of the researchers justified the sample size of their study, larger samples have more statistical power to detect change and support conclusions that researchers draw from their results.

Finally, multiple studies cited above had more than one therapist treating the participants. This introduces the possibility of differences in treatment techniques that could be responsible for the results instead of the differing treatments themselves. While some of the researchers described efforts to reduce the possibility of this error by training the therapists together, having only one treating therapist would entirely eliminate this potential confounding variable.

Potential Negative Outcomes

Although most researchers have reported very few adverse effects from needling, it is still a somewhat invasive form of treatment and has the potential to cause various injuries. The most commonly reported adverse effects of dry needling are soreness and local bleeding in the area that was treated (e.g., see Cerezo-Téllez et al., 2016b; Llamas-Ramos et al., 2014; Mejuto-Vázquez et al., 2014). Without intervention, this post-needling soreness typically resolves quickly, with multiple studies describing an immediate increase in soreness post-needling, followed by a decrease within between one hour (Martín-Sacristán et al., 2022) and one week (Cerezo-Téllez et al., 2016b). Many studies only reported soreness in some patients (e.g., see Llamas-Ramos et al., 2014; Mejuto-Vázquez et al., 2014; Valiente-Castrillo et al., 2021), and some reported no adverse effects to treatment (e.g., see Cerezo-Téllez et al., 2016a; Gattie et al., 2021; Rodríguez-Jiménez et al., 2022). In a study on 36 adult participants, researchers examined

the efficacy of Kinesio taping in reducing post-needling soreness but found taping to be ineffective (Arias-Buría et al., 2020a).

Various researchers have studied potential causes of post-needling soreness. For example, Martín-Pintado-Zugasti and colleagues (2018) found associations between local twitch response, number of needle insertions, and post-needling soreness. In the study, participants with neck pain (n=120; 34 male, 86 female; ages 18-53) were assigned to one of four groups: a control that had a needle inserted laterally to the trigger point (no local twitch response elicited), a group where four local twitch responses were elicited, a group where six local twitch responses were elicited, and a group where needling continued until local twitch responses ceased. Researchers found that when a local twitch response was elicited, more pain was reported during the treatment as well as 24 hours afterward when compared to the control group (Martín-Pintado-Zugasti et al., 2018). These results suggest that trigger point dry needling without eliciting LTRs is less likely to result in post-needling soreness.

It is important to note, however, that the relationships between various needling techniques (e.g., whether LTRs must be elicited, number of needle insertions), post-needling soreness, and efficacy of treatment are still not well understood, and contradictions exist in literature. For example, in the foundational study mentioned above, Hong (1994) found the LTR to be necessary for effective treatment. A more recent study by Hakim and colleagues (2019) contradicted this finding, reporting that dry needling without eliciting LTR was more effective in reducing pain and improving range of motion than dry needling that elicited LTR. Conversely, another recent study found no association between the number of LTRs elicited and pain improvement (Martín-Sacristán et al., 2022).

While more serious injuries, such as a pneumothorax (collapsed lung) or damage to the surrounding tissues, are possible, these can be avoided if needling is performed correctly. Dry needling procedural guidelines presented in *Myofascial Pain and Dysfunction: The Trigger Point Manual* describe overall best practices, as well as considerations specific to each muscle group that minimize the potential for injury (Donnelly et al., 2019).

It is also important to note that none of the studies cited in this review found dry needling to be harmful to any of the outcome measures, including range of motion, pain pressure threshold, stiffness, and pain (with the exception of post-needling soreness, as discussed above).

Trigger Point Dry Needling Equally as Effective as Other Treatments

Although results from multiple studies cited above indicate that dry needling is more effective than other treatments for neck pain (Arias-Buría et al., 2020b; Cerezo-Téllez, 2016a, 2016b), other researchers have found it to be equally as effective as other treatment methods.

For example, in a study on female office workers with neck and/or shoulder pain, participants (n=42) were assigned to either a manual pressure (n=22) or dry needling condition (n=20). Those in the dry needling group received dry needling on one trigger point until local twitch responses stopped. Researchers found that disability and pain decreased in both groups with no significant difference between the groups. Similar findings were reported for pressure pain threshold and muscle stiffness and elasticity (De Meulemeester et al., 2017).

Llamas-Ramos and colleagues (2014) reported similar findings, with improvements found in neck pain intensity, neck disability, and cervical range of motion in both a manual therapy group (n=47) and a dry needling group (n=47) at one- and two-week follow up measurements. The only significant difference noted between the groups was that greater improvements in PPT were found in the dry-needling group (Llamas-Ramos et al., 2014). Another recent study further

supported this finding with respect to the immediate effects of dry needling (Rodríguez-Jiménez et al., 2022). These results were supported, even in studies with multiple treatment sessions. For example, Ziaeifar and colleagues (2019) found trigger point dry needling (n=16) to have similar effects as manual compression (n=17) on neck pain after three treatments. These findings suggest that manual pressure and dry needling are equally as effective in the treatment of neck and shoulder pain.

The evidence presented by these studies suggests that while trigger point dry needling is an effective method to reduce neck pain, other less-invasive methods are equally applicable and might even be seen as a better option for patients who dislike or are apprehensive of needles or are concerned about potential negative outcomes of dry needling.

Additionally, while multiple studies cited above found dry needling directly on a trigger point to be more effective at reducing pain than needling performed outside of a trigger point, a recent study by Martín-Rodríguez and colleagues (2019) presented contradictory findings. Researchers examined the effects of dry needling on pain and motor control in the neck. Unlike many of the other studies cited in this review, dry needling was performed on the sternocleidomastoid muscle. Participants with neck pain (n=31) were split into two groups: a control group (n=17) which received dry needling 1.5 cm away from an active trigger point, and an experimental group (n=17), which received dry needling of one trigger point in the sternocleidomastoid. No significant differences were found between the control and experimental groups. However, both groups had significant decreases in pain scores, with the reduction being reported one-week post treatment in the experimental group and one-month post treatment in the control group (Martín-Rodríguez et al., 2019). These results further indicate that

trigger point dry needling may be no more effective than other treatments, including dry needling done outside of a trigger point.

Trigger Point Dry Needling Equally as Effective as Sham Treatment

Although all studies described and cited above found trigger point dry needling to be an effective form of treatment for neck pain, some researchers have found evidence to the contrary through sham-controlled studies. In a recent study by Valera-Calero and colleagues (2022), participants (n=60) were separated into a control group (n=28), which received one session of sham needling at one location on the upper trapezius, and an experimental group (n=32) that received trigger point dry needling on one active trigger point in the upper trapezius until one local twitch response was observed. Although the dry needling group was found to have significantly more improved PPT at a control point on the muscle that was needled, both groups showed increased PPT at the trigger point, with no significant difference between them. No differences were found between pre- and immediate post-treatment measurements of stiffness of the trigger point in either group. The methodological strengths of this study add credibility to these findings. These include the relatively large sample size compared to other studies cited here and a treating therapist with 10+ years of experience both identifying and needling the participants (Valera-Calero et al., 2022).

A recent study by Gattie and colleagues (2021) provides further support for the idea that dry needling may only be equally as effective as a sham treatment. Participants with neck pain (n=77, average age= 46.68 yrs) were randomly separated into either a control group, which received sham needling, or an experimental group, which received a dry needling session with a physical therapist. Both groups were also treated with manual therapy and did exercises as a part of their treatment. The experimental group received dry needling in six to 10 trigger points in the

posterior muscles of the cervical and thoracic spine for 25-30 s each. The patients assigned to the sham needling group underwent a treatment that simulates the feeling of dry needling, but the needles do not actually enter the skin. Researchers found that while both had significantly improved levels of disability, average pain, and current pain at four weeks, six months, and one year when compared to baseline, no significant differences were found between the groups (Gattie et al., 2021). Researchers postulated that the reported improvement could have been a result of the manual treatment and exercise the patients were receiving along with the dry needling or sham needling (Gattie et al., 2021).

Taken together, these studies suggest that trigger point dry needling is no more effective than a sham treatment, both short or long-term, for neck pain or the associated secondary symptoms such as low PPT and increased stiffness. The findings of Gattie and colleagues (2021) are especially notable because of the insight they provide into the potential lack of significant long-term effects.

Potential Explanations for Contradictory Findings

Many of the studies that found trigger point dry needling to be either equally as effective as other types of treatment or no more effective than a sham treatment contained the same limitations as those discussed above. Some of these limitations could potentially explain the fact that their findings contradict those of other researchers.

The most notable limitation, which is inherent to the topic being studied, is the lack of consistency among treating therapists. Although the treating therapists in the studies cited in this section had many years of experience with needling, as evidenced by stated statistics of between 6 and 10+ years of experience and the description of therapists as “experienced” or “expert,” it is possible that there were procedural issues that caused the treatment to fail in studies that found

no difference or no effect. This could result from needling a latent trigger point instead of an active one, only needling certain trigger points and leaving some that could be causing the patient's pain untreated, or incorrect identification of the trigger points (Donnelly et al., 2019).

Additionally, the measurement tools used to quantify subjective experience differed across studies and could have affected how patients rated their pain. Although the literature suggests that in the rating of neck pain intensity, the VAS and the NPRS (the two scales used in the articles in this review) are significantly correlated, it has been found that patients rate their pain higher on the NPRS than on the VAS, a trend which decreases over time (Kamper et al., 2015). Because the studies cited above reported clinically relevant changes in pain, it is unlikely that the variation in scales had a large impact, but it is nonetheless an inconsistency across studies that is worth noting.

The limitations identified here highlight gaps in the collective understanding of trigger point dry needling that present potential avenues for future research. First, where possible, sample size and study duration should be maximized. With only one study cited in this review containing outcome measurements after six months, it is clear that more research is needed specifically on the long-term effects of trigger point dry needling (Gattie et al., 2021).

Conclusion

In conclusion, although some contradictory findings and gaps in the literature exist, the majority of the studies reviewed above suggest that trigger point dry needling is effective in decreasing neck pain intensity and improving associated symptoms, including increasing range of motion and pain pressure threshold. These findings, along with the fact that none of the studies cited any major adverse effects, indicate that trigger point dry needling should be

considered as a treatment option for healthcare professionals in the care of adult patients with neck pain.

References

Arias-Buría, J. L., Franco-Hidalgo-Chacón, M. M., Cleland, J. A., Palacios-Ceña, M., Fuensalida-Novo, S., & Fernández-de-las-Peñas, C. (2020a). Effects of Kinesio taping on post-needling induced pain after dry needling of active trigger point in individuals with mechanical neck pain. *Journal of Manipulative and Physiological Therapeutics*, *43*(1), 32-42. https://doi.org/10.1016/j.jmpt.2019.02.011

Arias-Buría, J. L., Monroy-Acevedo, Á., Fernández-de-las-Peñas, C., Gallego-Sendarrubias, G. M., Ortega-Santiago, R., & Plaza-Manzano, G. (2020b). Effects of dry needling of active trigger points in the scalene muscles in individuals with mechanical neck pain: A randomized clinical trial. *Acupuncture in Medicine*, *38*(6), 380-387. https://doi.org/10.1177/0964528420912254

Cerezo-Téllez, E., Lacomba, M. T., Fuentes-Gallardo, I., Mayoral del Moral, O., Rodrigo-Medina, B., & Ortega, C. G. (2016a). Dry needling of the trapezius muscle in office workers with neck pain: A randomized clinical trial. *Journal of Manual & Manipulative Therapy*, *24*(4), 223-232. https://doi.org/10.1179/2042618615Y.0000000004

Cerezo-Téllez, E., Torres-Lacomba, M., Fuentes-Gallardo, I., Perez-Muñoz, M., Mayoral-del-Moral, O., Lluch-Girbés, E., Prieto-Valiente, L., & Falla, D. (2016b). Effectiveness of dry needling for chronic nonspecific neck pain: A randomized, single-blinded, clinical trial. *Pain*, *157*(9), 1905-1917. https://doi.org/10.1097/j.pain.0000000000000591

De Meulemeester, K. E., Castelein, B., Coppieters, I., Barbe, T., Cools, A., & Cagnie, B. (2017). Comparing trigger point dry needling and manual pressure technique for the management of myofascial neck/shoulder pain: A randomized clinical trial. *Journal of Manipulative and Physiological Therapeutics*, *40*(1), 11-20. https://doi.org/10.1016/j.jmpt.2016.10.008

Gattie, E., Cleland, J. A., Pandya, J., & Snodgrass, S. (2021). Dry needling adds no benefit to the treatment of neck pain: A sham-controlled randomized clinical trial with 1-year follow-up. *Journal of Orthopaedic & Sports Physical Therapy*, *51*(1), 37-45. https://doi.org/10.2519/jospt.2021.9864

Hakim, I. K., Takamjani, I. E., Sarrafzadeh, J., Ezzati, K., & Bagheri, R. (2019). The effect of dry needling on the active trigger point of upper trapezius muscle: Eliciting local twitch response on long-term clinical outcomes. *Journal of Back and Musculoskeletal Rehabilitation*, *32*, 717-724. https://doi.org/10.3233/BMR-181286

Hong, C. -Z. (1994). Lidocaine injection versus dry needling to myofascial trigger point: The importance of the local twitch response. *American Journal of Physical Medicine & Rehabilitation*, *73*(4), 256-263. https://doi.org/10.1097/00002060-199407000-00006

Kamper, S. J., Grootjans, S. J. M., Michaleff, Z. A., Maher, C. G., McAuley, J. H., & Sterling, M. (2015). Measuring pain intensity in patients with neck pain: Does it matter how you do it? *Pain Practice*, *15*(2), 159-167. https://doi.org/10.1111/papr.12169

Lewit, K. (1979). The needle effect in the relief of myofascial pain. *Pain*, *6*(1), 83-90. https://doi.org/10.1016/0304-3959(79)90142-8

Llamas-Ramos, R., Pecos-Martín, D., Gallego-Izquierdo, T., Llamas-Ramos, I., Plaza-Manzano, G., Ortega-Santiago, R., Cleland, J., & Fernández-de-las-Peñas, C. (2014). Comparison of the short-term outcomes between trigger point dry needling and trigger point manual therapy for the management of chronic mechanical neck pain: A randomized clinical trial. *Journal of Orthopaedic & Sports Physical Therapy*, *44*(11), 852-861. https://doi.org/10.2519/jospt.2014.5229

Maher, R. M., Hayes, D. M., & Sinohara, M. (2013). Quantification of dry needling and posture effects on myofascial trigger points using ultrasound shear-wave elastography. *Archives of Physical Medicine and Rehabilitation*, *94*, 2146-2150. https://doi.org/10.1016/j.apmr.2013.04.021

Martín Rodríguez, A., Sáez-Olmo, E., Pecos-Martín, D., & Calvo-Lobo, C. (2019). Effects of dry needling in the sternocleidomastoid muscle on cervical motor control in patients with neck pain: A randomised clinical trial. *Acupuncture in Medicine*, *37*(3), 151-163. https://doi.org/10.1177/0964528419843913

Martín-Pintado-Zugasti, A., Fernández-Carnero, J., León-Hernández, J. V., Calvo-Lobo, C., Beltran-Alacreu, H., Alguacil-Diego, I., Gallego-Izquierdo, T., & Pecos Martin, D. (2018). Postneedling soreness and tenderness after different dosages of dry needling of an active myofascial trigger point in patients with neck pain: A randomized controlled trial. *Physical Medicine and Rehabilitation*, *10*, 1311-1320. https://doi.org/10.1016/j.pmrj.2018.05.015

Martín-Sacristán, L., Calvo-Lobo, C., Pecos-Martín, D., Fernández-Carneo, J., & Alonso-Pérez, J. L. (2022). Dry needling in active or latent trigger point in patients with neck pain: a randomized clinical trial. *Scientific Reports*, *12*, Article 3188. https://doi.org/10.1038/s41598-022-07063-0

Mejuto-Vázquez, M. J., Salom-Moeno, J., Ortega-Santiago, R., Truyols-Domínguez, S., & Fernández-de-las-Peñas, C. (2014). Short-term changes in neck pain, widespread pressure pain sensitivity, and cervical range of motion after the application of trigger point dry needling in patients with acute mechanical neck pain: A randomized clinical trial.

Journal of Orthopaedic & Sports Physical Therapy, *44*(4), 252-260. https://www.jospt.org/doi/10.2519/jospt.2014.5108

Pecos-Martín, D., Montañez-Aguilera, F. J., Gallego-Izquierdo, T., Urraca-Gesto, A., Gómez-Conesa, A., Romero-Franco, N., & Plaza-Manzano, G. (2015). Effectiveness of dry needling on the lower trapezius in patients with mechanical neck pain: A randomized controlled trial. *Archives of Physical Medicine and Rehabilitation*, *96*, 775-781. https://doi.org/10.1016/j.apmr.2014.12.016

Rodríguez-Jiménez, J., Ortega-Santiago, R., Bonilla-Barba, L., Falla, D., Fernández-de-las-Peñas, C., & Florencio, L. L. (2022). Immediate effects of dry needing[1] or manual pressure release of upper trapezius trigger points on muscle activity during the craniocervical flexion test in people with chronic neck pain: A randomized clinical trial. *Pain Medicine*, *23*(10), 1717-1725. https://doi.org/10.1093/pm/pnac034

Safiri, S., Kolahi, A. -A., Hoy, D., Buchbinder, R., Mansournia, M. A., Bettampadi, D., Ashrafi-Asgarabad, A., Almasi-Hashiani, A., Smith, E., Sepidarkish, M., Cross, M., Qorbani, M., Moradi-Lakeh, M., Woolf, A. D., March, L., Collins, G., & Ferreira, M. L. (2020). Global, regional, and national burden of neck pain in the general population, 1990-2017: Systematic analysis of the Global Burden of Disease Study 2017. *The BMJ*, 368:m791. https://doi.org/10.1136/bmj.m791

Simons, D. G., Travell, J. G., Simons, L. S. (2019). *Travell, Simons & Simons' myofascial pain and dysfunction: The trigger point manual*. (3rd ed.). (J. M. Donnelly, Ed.). Wolters Kluwer.

[1] The published article includes this typographical error

Tsai, C. -T., Hsieh, L. -F., Kuan, T. -S., Kao, M. -J., Chou, L. -W., & Hong, C. -Z. (2010). Remote effects of dry needling on the irritability of the myofascial trigger point in the upper trapezius muscle. *American Journal of Physical Medicine & Rehabilitation*, *89*(2), 133-140. https://doi.org/10.1097/PHM.0b013e3181a5b1bc

University of Maryland Medical Center. (n.d.) Neck Pain Overview. https://www.umms.org/ummc/health-services/orthopedics/services/spine/patient-guides/neck-pain-overview

Valera-Calero, J. A., Sánchez-Jorge, S., Buffet-García, J., Varol, U., Fernández-de-las-Peñas, C., & Álvarez-González, J. (2022). Changes in stiffness at active myofascial trigger points of the upper trapezius after dry needling in patients with chronic neck pain: A randomized controlled trial. *Acupuncture in Medicine*. Advance online publication. https://doi.org/10.1177/09645284221104831

Valiente-Castrillo, P., Martín-Pintado-Zugasti, A., Calvo-Lobo, C., Beltran-Alacreu, H., & Fernández-Carnero, J. (2021). Effects of pain neuroscience education and dry needling for the management of patients with chronic myofascial neck pain: a randomized clinical trial. *Acupuncture in Medicine, 39*(2), 91-105. https://doi.org/10.1177/0964528420920300

World Health Organization. (2022, July 14). *Musculoskeletal Health*. https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions

Ziaeifar, M., Arab, A., M., Mosallanezhad, Z., & Nourbakhsh, M. R. (2019). Dry needling versus trigger point compression of the upper trapezius: A randomized clinical trial with two-week and three-month follow-up. *Journal of Manual & Manipulative Therapy, 27*(3), 152-161. https://doi.org/10.1080/10669817.2018.1530421