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MYOFASCIAL PAIN AND TREATMENT: NARRATIVE REVIEW

The local twitch response during trigger point dry needling: Is it necessary for successful outcomes?

Thomas Perreault, DPT [a, *], James Dunning, DPT, MSc, FAAOMPT [a, b], Raymond Butts, DPT, PhD, MSc [a]

[a] Faculty, American Academy of Manipulative Therapy Fellowship in Orthopedic Manual Physical Therapy, Senior Instructor, Spinal Manipulation Institute & Dry Needling Institute, Montgomery, AL, USA
[b] Alumno de Doctorado, Escuela Internacional de Doctorado, Universidad Rey Juan Carlos, Alcorcon, Madrid, Spain

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ABSTRACT

Background: Myofascial trigger point (MTrP) injection and trigger point dry needling (TrPDN) are widely accepted therapies for myofascial pain syndrome (MPS). Empirical evidence suggests eliciting a local twitch response (LTR) during needling is essential.
Objective: This is the first review exploring the available literature, regardless of study design, on the neurophysiological effects and clinical significance of the LTR as it relates to reductions in pain and disability secondary to MTrP needling.
Methods: PubMed, MEDLINE, Science Direct and Google Scholar were searched up until October 2016 using terms related to trigger point needling and the LTR.
Results: and Discussion: Several studies show that eliciting a LTR does not correlate with changes in pain and disability, and multiple systematic reviews have failed to conclude whether the LTR is relevant to the outcome of TrPDN. Post needling soreness is consistently reported in studies using repeated in and out needling to elicit LTRs and increases in proportion to the number of needle insertions. In contrast, needle winding without LTRs to MTrPs and connective tissue is well supported in the literature, as it is linked to anti-nociception and factors related to tissue repair and remodeling. Additionally, the positive biochemical changes in the MTrP after needling may simply be a wash out effect related to local vasodilation. While the LTR during TrPDN appears unnecessary for managing myofascial pain and unrelated to many of the positive effects of TrPDN, further investigation is required.

1. Introduction

Myofascial pain syndrome (MPS) is a highly prevalent condition without clear evidence-based clinical guidelines for optimal management (Fleckenstein et al., 2010). According to a recent international survey, pain specialists consider MPS to be a readily distinguishable condition involving local muscle pain and the presence of tender spots that reproduce symptoms when pressure is applied (Rivers et al., 2015). Clinically, MPS is associated with the presence of myofascial trigger points (MTrPs), which are often the focus of examination and treatment (Shah et al., 2015). A MTrP is a palpable, hyperirritable nodule located within a taut band of skeletal muscle fibers that is classified into an active (A-MTrP) or latent (L-MTrP) myofascial trigger point (Ge et al., 2011). A-MTrPs are associated with pain recognition when manually stimulated, and often present with predictable pain referral patterns (Myburgh et al., 2008); furthermore, A-MTrPs have the potential to cause both peripheral and central sensitization (Fernandez-de-las-Penas and Dommerholt, 2014; Hsieh et al., 2007). L-MTrPs are only painful with compression or palpation (Bron et al., 2011), however, they may predispose patients to altered movement patterns (Ge et al., 2012, 2014; Ibarra et al., 2011; Lucas et al., 2010; Sergienko and Kalichman, 2015) and/or be converted to A-MTrPs when perpetuating factors are present (Ge and Arendt-Nielsen, 2011). Importantly, MTrPs are prevalent in patients with musculoskeletal pain (Alburquerque-García et al., 2015; Arendt-Nielsen, 2015; Bron et al., 2011; Castaldo et al., 2014; Fernandez-Carnero et al., 2007;

* Corresponding author. American Academy of Manipulative Therapy, 1036 Old Breckenridge, Ln., Montgomery, AL, 36117, USA.
E-mail address: tommy.perreault@gmail.com (T. Perreault).

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Fernández-de-las-Peñas et al., 2005; Sergienko and Kalichman, 2015) and a multitude of causes for MTrP development have been suggested (Campa-Moran et al., 2015; Huang et al., 2014; Itoh et al., 2004; Lin et al., 2011; Ruiz-Saez et al., 2007; Treaster et al., 2006; Tsai et al., 2009). MTrP injection and trigger point dry needling (TrPDN) are commonly applied interventions for MTrP pain (Kuan, 2009). Several studies suggest the effects of injection therapy are largely due to mechanical disruption of muscle fibers and nerve endings from the prick of the needle, not solely from the infiltration of a local anesthetic (Ay et al., 2010; Cummings and White, 2001; Venancio Rde et al., 2008). Thus, TrPDN—i.e. without injectate—is becoming a popular therapeutic intervention among health professionals (Rodriguez-Mansilla et al., 2016) and involves the insertion of thin monofilament (Cerezo-Tellez et al., 2016a) or hollow bore needles (Kamanli et al., 2005) without delivery of any drug into a MTrP region. Current systematic reviews report that direct MTrP needling is superior only to placebo for reducing pain (Tough and White, 2011) at immediate (Kietrys et al., 2013), short-term (Boyles et al., 2015; Kietrys et al., 2013; Liu et al., 2015) and medium-term (Liu et al., 2015) follow up. However, the effectiveness of TrPDN over placebo for pain reduction in the long-term remains unknown (Kietrys et al., 2013; Ong and Claydon, 2014). A recent systematic review of 19 randomized controlled trials (RCTs) concluded that TrPDN may be effective for MTrP pain reduction across multiple body regions and conditions, but no consensus was determined about the most effective needling techniques for pain relief (Boyles et al., 2015). More specifically, some authors suggest that TrPDN is most effective if a local twitch response (LTR) is elicited during the procedure (Hong, 1994b; Tekin et al., 2013). The LTR is characterized by a visible contraction of part of the taut band in the involved muscle upon mechanical stimulation with needling or palpation to a sensitive site in a MTrP region (Simons and Dexter, 1995). To elicit LTRs, many clinicians use a fast-in and fast-out needling technique often referred to as “pistoning” in a fan or cone shape, for the deactivation of MTrPs (Calvo-Lobo et al., 2015, 2016; Tellez-Garcia et al., 2015). Notably, the use of needle pistoning, with the goal of eliciting single or multiple LTRs in the muscle belly, was a dominant theme in the methodology of the majority of studies included in a recent systematic review that investigated the effectiveness of dry needling on MTrP related pain (Morihisa et al., 2016). However, although needling (dry or wet) with the production of LTRs has been shown to reduce MTrP related pain in the immediate, short, and medium term, the long-term outcomes remain unknown. Furthermore, and more importantly, whether needling with the elicitation of the LTR leads to superior outcomes for the reduction of pain and disability when compared to needling interventions without the LTR remains largely unexplored (Boyles et al., 2015; Gerber et al., 2015; Hong, 1994b; Kuan et al., 2012; Rha et al., 2011; Tekin et al., 2013). In addition, the physiologic importance of the LTR during TrPDN remains to be elucidated (Kuan et al., 2012), and no systematic reviews to date have provided firm conclusions linking the LTR phenomenon directly to the positive clinical outcomes experienced by patients with MPS following the use of TrPDN (Boyles et al., 2015; Cagnie et al., 2015; Cummings and White, 2001; Kietrys et al., 2013). Given that other needling techniques and manual therapies have shown efficacy in the management of myofascial pain and do not rely on eliciting the LTR (Cagnie et al., 2012, 2015; Kostopoulos et al., 2008; Takano et al., 2012), a more detailed investigation of the clinical relevance of the LTR seems appropriate. Therefore, the purpose of this narrative review is to comprehensively investigate the available literature to determine whether or not elicitation of the LTR is a necessary event during dry or wet needling for the optimal short and/or long-term reduction of pain and disability in patients with MPS.

2. Materials and methods

Literature for this narrative review was sought that investigated the LTR phenomenon during MTrP needling. Articles that provided insight on the neurophysiological mechanisms of MTrP needling and the LTR were included, along with studies that assessed the clinical relevance of the LTR. The reference lists of these studies were also hand searched to identify other articles relevant to the topic of the LTR. Importantly, individual studies that investigated the role of the LTR as it pertains to the outcome of pain intensity with TrPDN or MTrP injection in human subjects with MPS or other painful musculoskeletal conditions were included and listed in Table 1. Consistent with our intent of performing a narrative review, the search was not limited to randomized controlled trials, systematic reviews or meta-analyses. In addition, no restrictions were placed on the date of article publication and only articles written in English were reviewed. An electronic database search of PubMed, MEDLINE, Science Direct and Google Scholar were searched up until October 2016 using the following terms; dry needling, injection, acupuncture AND local twitch response, twitch response, myofascial pain, trigger point, mechanisms. All articles that did not meet the above criteria were discarded.

3. Results and discussion

In this narrative review, 6 studies were identified that all investigated the clinical importance of eliciting the LTR with MTrP injection or TrPDN as it pertains to the outcome of pain intensity and they are summarized in Table 1. The studies included two randomized controlled trials (Hong, 1994b; Tekin et al., 2013), one prospective, non-randomized, controlled, interventional clinical study (Gerber et al., 2015), one case control study (Rha et al., 2011), one single-arm cohort study (Kuan et al., 2012) and one quasi-experimental study (Koppenhaver et al., 2016). Importantly, only a single study assessed the influence of eliciting the LTR on changes in disability in addition to pain intensity (Koppenhaver et al., 2016). All other studies referenced in this review have relevance to the topic of MTrP injection or TrPDN for the management of MPS.

3.1. Dry needling technique and the localized twitch response

Empirical evidence suggests that eliciting multiple LTRs through mechanical stimulation of a MTrP within a taut band is the most important factor for pain relief (Chou et al., 2014; Hong and Simons, 1998; Hsieh et al., 2007). Some authors have suggested that the LTR during TrPDN is a sensitive measure (Ge et al., 2008) and an objective confirmation (Simons and Travell, 1999) of needle insertion into a trigger point, the location thought to have the greatest therapeutic effect (Hong, 1994a). Developed by Hong (Hong, 1994a, 2013; Hong and Simons, 1998) and now broadly used by practitioners for MTrP injection and TrPDN, the “multiple rapid insertion technique” in a fan or cone shape is intended to provide high-pressure mechanical stimulation to “sensitive loci”—i.e. sensitized afferent fibers—stimulating a subset of the α-motor neurons in the spinal cord. The LTR is thought to subsequently break the vicious cycle of the MTrP circuit, decreasing pain and disability (Audette et al., 2004; Chou et al., 2014; Hong and Simons, 1998; Kuan et al., 2012). Importantly, the sensitive afferents that proliferate in the MTrP region (Hong et al., 1997a; Meng et al., 2015b), mediate both the noxious input to the spinal cord (Meng et al., 2015a) and the LTR induced through needling precise MTrP locations (Hong and Torigoe, 1994; Simons et al., 1995). Resting pain intensity of the MTrP before injection has been found to be highly correlated with LTR prevalence during injection (i.e. the higher the baseline pain intensity, the more LTRs that were elicited), suggesting that

Table 1
Summary of clinical studies investigating the local twitch response.

Study	Subjects	Interventions	Findings on LTR
Hong (1994b)	58 patients with UT MPS	TrPDN or Lidocaine MTrP injection into UT MTrPs	Pain intensity was significantly reduced immediately after TrPDN or MTrP injection without significant between group differences if LTR was elicited. Minimal to no treatment effects observed without eliciting the LTR. Immediate and 2 week follow up.
Rha et al. (2011)	103 patients (41 with MTrPs in UT, 62 with MTrPs in ES or QL	US guided MTrP Injection to UT, ES or QL	Pain reduction was more significant when LTR was elicited for both groups receiving MTrP Injection of UT, ES or QL. Immediate follow up.
Tekin et al. (2013)	39 patients with MPS	TrPDN of upper quarter MTrPs or sham TrPDN	Patients in TrPDN group with LTR had better reduction in pain than those without LTR. Follow up at end of treatment (4 weeks).
Gerber et al. (2015)	56 subjects with neck or shoulder girdle pain and UT MTrPs	TrPDN of UT MTrPs	Elicitation of the LTR did not distinguish responders from non-responders. Change in pain not statistically correlated with eliciting the LTR. Follow up at end of treatment (3 weeks).
Kuan et al. (2012)	72 subjects with UT MPS	MTrP Injection into UT	Weak correlation found between pain relief after injection and LTR prevalence during injection. Immediate follow up.
Koppenhaver et al. (2016)*	66 patients with LBP	TrPDN to L3, L4, L5 multifidus muscles bilaterally	No between group differences between subjects experiencing a LTR and those without LTR in pain intensity or disability on the ODI at immediate or 1 week follow up.

*Denotes studies that assessed the influence of the LTR on disability measures.
QL = quadratus lumborum; UT = upper trapezius; ES = erector spinae; US = ultrasound.

the number of sensitized nociceptors in the MTrP region is proportionate to the MTrP irritability (Kuan et al., 2012). Moreover, early studies (Hong, 1994b; Hong et al., 1997b) also observed that the number of LTRs elicited was directly proportional to subjective pain intensity before needling of MTrPs. Hong et al. (1997b) further found the LTR was elicited in 100% of MTrPs treated with needling, while manual palpation prior to injection was only able to elicit the LTR in 39% of the same MTrPs, a phenomenon which is likely due to the needle tip's ability to directly stimulate sensitive loci (Hong et al., 1997b).

3.2. Pathophysiology of the localized twitch response

TrPDN to elicit the LTR is associated with neurophysiological responses (Cagnie et al., 2013) that may contribute to its therapeutic effects. An earlier animal study showed that fast, rapid dry needling resulted in more LTRs and end plate discharges when compared to slow needle insertion (Chen et al., 2001). Consequently, suppression of motor end plate activity was more pronounced with rapid dry needling to elicit multiple LTRs and may have led to more acetylcholine depletion at the neuromuscular junction. Likewise, injection of botulinum neurotoxin A into MTrPs has shown efficacy in treating myofascial pain (Zhou and Wang, 2014) by blocking the release of acetylcholine from peripheral nerves, and decreasing motor endplate activity (Kuan et al., 2002). Recently, motor end plate activity was normalized after eliciting LTRs with dry needling to MTrPs of human subjects with trapezius MPS. In addition, the improvement in pain intensity that occurred in the 20 subjects was accompanied by decreased sympathetic hyperactivity measured through sympathetic skin response (Abbaszadeh-Amirdehi et al., 2016a, 2016b). Importantly, another current study reported eliciting the LTR with TrPDN in human subjects with MPS was more effective for reducing surface EMG activity of the upper trapezius when compared to needling without LTRs provoked (De Meulemeester et al., 2016). In a novel animal study by Hsieh et al. (2011), eliciting a LTR in distal MTrPs suppressed motor end plate activity in a proximal but segmentally related muscle (Hsieh et al., 2011). Thus, there seems to be a positive correlation between reduction in motor end plate irritability and the LTR following TDN to either a local or remote MTrP (Chou et al., 2009, 2011). Remarkably, motor endplate irritability in the MTrP region is strongly associated with pain intensity (Kuan et al., 2007) and TrPDN to evoke LTRs has been shown to suppress motor endplate activity (i.e. deplete acetylcholine levels) and decrease MTrP pain simultaneously (Chou et al., 2011). However, underlying pathologies of non-muscular origin such as facet joint dysfunction (Hong, 2006; Tsai et al., 2009) may contribute to MTrP formation. Moreover, facet injections (Huang et al., 2014; Tsai et al., 2009) and spinal manipulation (Ruiz-Saez et al., 2007) have been shown to decrease endplate activity and pain, respectively, related to trigger points. Additionally, alterations in the visco-elastic properties of fascia (Stecco et al., 2013) and biomechanical deficiencies (Gerwin, 2001) have also been linked with the formation and propagation of MTrPs. Thus, the LTR may lead to short term pain relief by reducing muscle hyperexcitability, but long-term outcomes will likely not be achieved if the underlying etiology of the condition is something other than muscle tissue (Hong, 2006).

TrPDN to MTrPs has been shown to increase B-endorphins (Hsieh et al., 2012, 2016) and decrease CGRP and SP when measured after the occurrence of a LTR (Shah et al., 2005, 2008; Shah and Gilliams, 2008). However, the physiologic mechanism responsible for these biochemical changes following the LTR remains unknown (Kuan et al., 2012). On the other hand, the LTR may be unrelated to changes in opioids, CGRP and SP. Instead, TrPDN may simply cause vasodilation, resulting in the delivery of opioid producing leukocytes and “washing out” sensitizing substances such as CGRP and SP (Shah and Gilliams, 2008). Moreover, dry needling has been shown to elicit increases in local circulation near the site of needle insertion in the absence of a LTR (Ohkubo et al., 2009; Sandberg et al., 2004, 2005). Cagnie et al. (2012) reported local blood flow in the upper trapezius was 72% higher than baseline levels 15 min after exposure to dry needling in healthy subjects, a result that did not require a LTR (Cagnie et al., 2012). In other studies, blood flow increases with needling in a dose dependent manner and remains elevated for 60 min without the report of a LTR (Shinbara et al., 2008).

Interestingly, studies from the acupuncture literature report an initial increase of CGRP and SP after needling in the absence of a LTR (Butts et al., 2016; Wu et al., 2015). The added CGRP may initiate a cascade of vasodilators, to include nitric oxide, which may lead to a washout effect (Shinbara et al., 2013, 2015). Alternatively, the CGRP and SP may work to provide negative feedback onto autoreceptors, ultimately decreasing the release of CGRP and SP (Zhang et al., 2012). There is also evidence that the simultaneous release of SP may work to counter peripheral levels of CGRP (Zijlstra et al., 2003). The latter explanation is particularly interesting, as CGRP has been shown to propagate inflammation in high quantities but provide potent anti-inflammatory actions in low quantities (Zijlstra et al.,

2003). In this case, leaving needles in situ with intermittent stimulation via winding or electric stimulation may be more advantageous than TrPDN with a LTR, as it may facilitate continuous low levels of SP and CGRP over time, thereby leading to lasting reduction of peripheral pain (Butts et al., 2016).

3.3. Clinical relevance of the localized twitch response

According to a recent narrative review, there is a sizeable consensus that elicitation of a LTR provides greater immediate and long-term pain relief with needling therapy than no LTR (Shah et al., 2015). However, this assumption is based on very limited research and relies predominantly on clinical observation. Ga et al. (2007a, 2007b, 2007c) conceded that the LTR experienced by the majority of subjects over 3 treatments of MTrP needling, likely contributed to positive clinical outcomes (Ga et al., 2007a, b; Ga et al., 2007c). While this is consistent with other recent studies reporting a high occurrence of LTRs in subjects treated with TrPDN (Cerezo-Tellez et al., 2016b; Ma et al., 2010), the significant reductions in pain observed in the treatment groups were not directly compared to a group where needling was performed without inducing a LTR. In fact, few studies have isolated elicitation of the LTR during TrPDN as a variable that is more beneficial than not eliciting one in the treatment of trigger points for MPS or other conditions (See Table 1) (Boyles et al., 2015). An earlier review by Cummings and White, (2001) reported that only 1 out of 23 studies mentioned eliciting the LTR making it difficult to draw conclusions of its clinical relevance (Cummings and White, 2001). In a more recent systematic review, Cagnie et al. (2015) further reported a lack of clarity in the description of TrPDN technique across 8 studies, making it difficult to determine if the LTR contributes to TrPDN success (Cagnie et al., 2015). Similarly, Kietrys et al. (2013) could not clarify if eliciting the LTR was a necessary component of TrPDN in 8 of 12 studies that treated upper quarter myofascial pain (Kietrys et al., 2013). While Boyles et al. (2015) included 7 of 15 studies that described eliciting a LTR during TrPDN for multiple body regions, few studies reported if or how often LTRs were evoked during treatment. Thus, no firm conclusions can be made concerning the importance of the LTR during TrPDN to treatment outcomes (Boyles et al., 2015).

A number of recent studies that have yet to be included in current systematic reviews further challenge the assumption that the LTR is necessary for effective TrPDN. Gerber et al. (2015) and Suh et al. (2014) found no correlation between LTR occurrence during TrPDN of the upper trapezius and brachialis muscles, respectively, and pain reduction or treatment success rate (Gerber et al., 2015; Suh et al., 2014). Koppenhaver et al. (2016) also studied the LTR elicited during TrPDN to the lumbar multifidus muscle at the L3, L4, and L5 spinal levels bilaterally in 66 subjects with low back pain to determine if it related to changes in pain, disability and muscle function. Importantly, the LTRs elicited on the most painful side and vertebral level in 53% of subjects were unrelated to reductions in pain and disability at immediate and 1 week follow up and did not lead to lasting change in muscle function. Furthermore, the authors concluded that the LTR should not be considered necessary for successful TrPDN (Koppenhaver et al., 2016). In another recent study, 3 weekly sessions of TrPDN were provided to 56 patients with neck or shoulder girdle pain and A-MTrPs in the upper trapezius with the aim of eliciting a LTR. Subsequently, the authors report 41 positive responders with a change in MTrP status from active to latent or no palpable nodule and a clinically relevant improvement on the VAS (Gerber et al., 2015), which persisted at the 6-week follow-up (Gerber et al., 2016). Interestingly, the elicitation of the LTR failed to distinguish responders from non-responders, and the occurrence of the LTR did not correlate with changes in pain (Gerber et al., 2015). Lim et al. (2008) further reported that 69% of subjects had a 50% reduction in pain from baseline following TrPDN, even though a low percentage of LTRs were actually elicited (Lim et al., 2008). Interestingly, Irnich et al. (2002) found that TrPDN was not effective for reducing pain because of increased soreness following the procedure, which may have resulted from the LTR (Irnich et al., 2002). However, one study reported that occurrence of the LTR did not contribute to increased pain during MTrP injection (Yoon et al., 2009). While Kuan et al. (2012) discovered that needle stimulation of MTrPs can more frequently elicit LTRs when pain intensity and trigger point irritability (i.e. number of sensitized nociceptors) is high, the degree of pain relief achieved with MTrP injection to the upper trapezius was not strongly associated with the mean LTR prevalence in 72 subjects with MPS. Rather, pain relief correlated with frequency of LTRs only when pain intensity was exceptionally high (Kuan et al., 2012).

3.4. The localized twitch response and short term pain relief

Hong (1994b) was the first to report significant pain reduction immediately post treatment only when the LTR was elicited with no difference between the use of lidocaine injection or dry needling in 41 of 58 patients with MPS (Hong, 1994b). However, the dry needling group experienced significant pain increase from post treatment to 2-week follow up, and this was reportedly due to the significant amount of post needling soreness. Thus, the improvements in pain seen after the LTR with TrPDN in the Hong (1994b) study were immediate only—i.e. were not present at 2-week follow-up. In a study on 39-patients with MPS, TrPDN resulted in significant reductions in pain and medication intake vs. non-penetrating sham needling, and patients who experienced the LTR had better improvements in pain scores at 4 weeks (Tekin et al., 2013). While subjects in the study who achieved a LTR had clinically meaningful reductions in pain (Koppenhaver et al., 2016), long term outcomes were not measured (Tekin et al., 2013). Using ultrasound guided MTrP injection, Rha et al. (2011) further investigated the clinical importance of eliciting the LTR. While pain reduction was more significant in patients that were LTR positive than LTR negative regardless of the muscle being treated (i.e. upper trapezius, quadratus lumborum, or erector spinae), pain was only assessed immediately after the needling procedure (Rha et al., 2011). Likewise, Bubnov and Wang (2013) found a significant correlation between eliciting the LTR during TrPDN and pain relief (i.e. 50% reduction in pain on VAS) in 133 subjects with MTrPs, but only immediate and 24 h follow up was observed (Bubnov and Wang, 2013).

3.5. Post needling soreness

Significant adverse events secondary to TrPDN performed by trained physical therapists are rare and have been calculated to be as low as 0.04% (Brady et al., 2014). However, the repeated needle insertion often required to elicit LTRs often leads to added micro trauma and post needling soreness, which can increase patients' resting pain levels instead of reducing them (Campa-Moran et al., 2015; Irnich et al., 2002; Martín-Pintado-Zugasti et al., 2016). Post needling soreness has been reported to occur in 100% of subjects receiving dry needling and appears to be associated with levels of local hemorrhage and the number of needle insertions (Hong, 1994b). Using the multiple rapid needling procedure on latent trigger points in 60 subjects, post needling soreness was present in 100% of subjects and resolved within 72 h (Martín-Pintado-Zugasti et al., 2016). Of importance, a higher number of needle insertions during the "pistoning" procedure correlated with higher pain levels after needling treatment (Martín-Pintado-Zugasti et al., 2016).

Other studies reported that post-needling soreness occurred in 50% or more (Ga et al., 2007a, b; Ga et al., 2007c; Martin-Pintado-Zugasti et al., 2015) of subjects who received dry needling using multiple needle insertion method to elicit the LTR, and the duration of soreness lasted more than 24 h. A recent study reported 100% of subjects treated with multiple rapid dry needle insertion to latent MTrPs in the upper trapezius developed immediate post needling soreness that resolved within 72 h (Martin-Pintado Zugasti et al., 2014). It has been previously reported that the fast needle movement during the multiple insertion method helps to prevent tissue injury (Hong, 2013), but skeletal muscle and intramuscular nerve damage have been reported with use of this method (Domingo et al., 2013). Domingo et al. (2013) reported that 1 session of 15 repeated needle punctures to healthy muscle tissue in mice led to mechanical injury near the neuromuscular junction, a rapid inflammatory reaction in the muscle and nerve terminal degeneration by Schwann cells within 24 h. Interestingly, re-innervation of end plates occurred within 3 days and skeletal muscle regeneration was seen at 1 week (Domingo et al., 2013). However, in clinical practice dry needling is commonly used over several treatments, so it is uncertain if the normal processes of muscle regeneration and nerve re-innervation occur after a series of needling treatments on symptomatic individuals. In fact, a higher dosage of needling to MTrPs has shown to result in overexpression of tumor necrosis factor (TNF-α) along the needle pathway and in the serum, increased SP levels in the treated muscle and dorsal root ganglion, and reductions in endogenous opioid levels (Hsieh et al., 2012), all evidence of skeletal muscle damage that may be counterproductive for pain management.

3.6. Alternative needling techniques

Strong effects are observed when MTrPs are the focus of dry needle stimulation due to the presence of sensitized nociceptors associated with the MTrP region (Hong et al., 1997a; Meng et al., 2015a, b). The multiple rapid needle insertion technique—i.e. one needle with one insertion point through the skin and into the target muscular trigger point, using repeated partial withdrawals to the subcutaneous tissue and then re-insertion with a different angulation in a fan or cone shape– is proposed to elicit its effects mainly through “pricking” sensitized nociceptors and inducing the LTR (Hong, 1994a). However, it remains unknown if this technique is superior to other forms of needling for the treatment of pain associated with MTrPs. In fact, strong stimulation may also be achieved through other forms of needle manipulation to bring about an analgesic effect (Choi et al., 2013). For example, winding instead of pistoning the needle initiates mechanotransduction of tissue, thereby activating TRPv1 receptors on peripheral nerve endings (Wu et al., 2014). TRPv1 receptors are unique because they are one of the only peripheral receptors activated by low pH, increased temperature and mechanical stimulation (Wu et al., 2014). Recent evidence supports manually inserting and rotating needles every 5 min for a total of 30 min durations leads to intracellular Ca2+ wave propagation and increases in extracellular ATP and adenosine for up to 60 min when measured by microdialysis (Goldman et al., 2010; Takano et al., 2012). The accumulation of adenosine activates A1 adenosine receptors and provides a strong anti nociceptive effect via inhibition of adenylate cyclase (Takano et al., 2012). The intracellular Ca2+ propagation also helps initiate rho kinase mediated tissue remodeling and blocks pain at the level of the spine by stimulating glycinergic and GABAergic interneurons (Butts et al., 2016; Goldman et al., 2013; Langevin et al., 2011; Zhou et al., 2008). Importantly, insertion (and likely repeated insertion) of the needle was shown to not be enough to activate TRPv1 receptors and initiate the analgesic cascade. Rather, increases in extracellular ATP and adenosine were only possible when connective tissue was coupled to the needle (i.e. mechanotransduction) via winding (Langevin, 2014). Furthermore, elicitation of a LTR is not necessary for this effect. According to Langevin et al. (2001) the mechanical stimulation induced by needle pistoning may be amplified when connective tissue is first coupled to the needle by winding, thus strengthening the mechanical signals transmitted to nearby or remote cells (Langevin et al., 2001). In fact, several studies have suggested enhanced LTR occurrence using needle rotation together with repeated in-and-out needle insertion (i.e. “screwing in-and-out technique”) during treatment of MTrPs (Chou et al., 2008, 2011, 2009). Therefore, needle pistoning in the absence of winding may not be justified to elicit mechanotransduction. Consistent with this finding, Zhang et al. (2012) reported greater activation of C-fibers, distal superficial and deep mechanoreceptors and stretch receptors with needle rotation compared to lifting, scraping, shaking, thrusting and flicking (Zhang et al., 2012). Thus, based on the evidence to date, the production of single or multiple LTRs during TrPDN seems to have poor correlation in the short-term, and no correlation for the long-term outcomes of pain and disability in patients with neck, shoulder or low back pain; however, the benefits of needle manipulation via winding of connective tissue, rather than repeated pistoning directly into a single muscular trigger point is well supported in the literature for both the short and long-term reduction of pain and disability (Dunning et al., 2014).

3.7. Segmental analgesia

TrPDN also helps elicit spinal segmental pain inhibitory effects (Mejuto-Vazquez et al., 2014; Srbely et al., 2010) and descending pain control pathways (Niddam et al., 2007) that may not rely on eliciting LTRs. Strong needle stimulation via winding stimulates the release endogenous opioids, which is considered one of the most potent mechanisms for pain suppression in the periphery and at the spinal cord level secondary to needling treatment (Chou et al., 2012; Zhang et al., 2014). Hsieh et al. (2016) demonstrated that needling distal but segmentally related MTrPs induced increases in enkephalin at the spinal dorsal horn and β-endorphin in the serum and dorsal root ganglion neurons. In addition, endogenous opioids were markedly increased in the proximal muscle in proportion to needle dosage (Hsieh et al., 2016). Most importantly, this study used slow and gentle needle insertion with rotation to MTrPs during a 30 s period and did not report eliciting a LTR (Hsieh et al., 2016). In clinical studies, deep needle stimulation to muscular afferents at acupuncture points and MTrPs with needle rotation, not multiple rapid insertions at the same entry point and with the same needle, demonstrated a superior treatment effect that persisted at 3 month follow up compared to superficial needling in subjects with chronic shoulder (Ceccheerelli et al., 2001) and lumbar myofascial pain (Ceccherelli et al., 2002), respectively.

3.8. Manual MTrP therapy

In a recent study on 94 patients with chronic neck pain, TrPDN with LTRs and trigger point manual release both resulted in significant reduction in pain without significant between group differences (Llamas-Ramos et al., 2014). Notably, manual pressure release does not involve the insertion of a needle or the elicitation of a LTR. Moreover, a recent study reported that manual MTrP compression was more effective than massage and non-MTrP compression for subjects with acute LBP. As in TrPDN with LTRs, the authors reported that the effects of MTrP compression may involve increased blood flow and suppression of acetylcholine at the neuromuscular junction (Takamoto et al., 2015), a finding that

has been confirmed by a recent micro dialysis study (Moraska et al., 2013). Moreover, ischemic compression of MTrPs has been shown to result in a significant reduction of SEA in the absence of a LTR (Kostopoulos et al., 2008).

4. Conclusion

Dry needling to elicit LTRs is a commonly used technique to treat MTrPs for the management of MPS; however, based on the evidence to date, the production of single or multiple LTRs during muscular TrPDN seems to have poor correlation in the short-term for the outcomes of pain and disability in patients with neck, shoulder or low back pain. Furthermore, there are no studies with long-term outcome data that have investigated the effect of, or need for, the LTR during TrPDN or acupuncture in patients with MPS or any musculoskeletal disorder. Nevertheless, the benefits of needle manipulation via needle rotation or winding of connective tissue, rather than repeated pistoning directly into muscular trigger points, is well supported in the literature. In addition, the number of needle insertions during "pistoning" at one insertion site appears to positively correlate with levels of post-needling soreness, increased levels of inflammation within muscle fibers, and mechanical injury at or near the neuromuscular junction. In addition, TrPDN using needle rotation (i.e. unidirectional or bidirectional winding) and manual MTrP techniques have been shown to elicit neurophysiological responses that can positively alter the MTrP status and reduce pain without the need for a LTR. Therefore, the LTR during TrPDN appears unnecessary and may not be required for managing myofascial pain and may be unrelated to many of the positive effects of dry needling. However, further investigation is required.

Conflicts of interest

Drs. Thomas Perreault, James Dunning and Raymond Butts are Senior Instructors for Dry Needling Institute (DNI) and also faculty members within the American Academy of Manipulative Therapy (AAMT) Fellowship in Orthopaedic Manual Physical Therapy. DNI and AAMT Fellowship offer post-graduate continuing education courses in dry needling for physical therapists and medical physicians.

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