Progressive pressure release versus dry needling on cervical latent trigger points
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Background
Latent myofascial trigger points (L-MTrPs) may account for the development of muscle cramps, restricted joint range of motion, muscle weakness, and accelerated fatigability. Progressive pressure release (PPR) and dynamic deep dry needling (DDDN) are two recognized techniques used in the management of myofascial trigger points.

Aim
The aim of this study was to compare the effect of both PPR and DDDN on pain and range of motion in upper trapezius L-MTrPs.

Setting and design
Single-blinded randomized trial design was used, in which 60 pain-free participants with more than two L-MTrPs in the upper trapezius were allocated randomly to two equal groups. Primary measurement outcome included pressure pain threshold (PPT) using an electronic digital algometer. Secondary outcome included active cervical lateral flexion and rotation using a baseline bubble inclinometer. Data were collected before the first treatment and at the end of the 8-week trial.

Participants and materials
There were five dropouts. The PPR group included 28 participants who received passive stretch and PPR, and the DDDN group included 27 participants who received passive stretch and DDDN. Both groups received 3 sessions/week for eight consecutive weeks.

Results
The PPR group showed a significant increase in PPT values ($P<0.01$), cervical lateral flexion ($P<0.006$), and rotation ($P<0.027$) compared with the DDDN group.

Conclusion
Within the scope of our study, we have concluded that both techniques have been effective in increasing PPT, cervical lateral flexion, and rotation. However, the PPR technique has been considered to be superior to DDDN in the management of cervical L-MTrPs.

Keywords:
dry needling, myofascial trigger points, pressure pain threshold, progressive pressure release

Introduction
Most chronic pain disorders involve myofascial pain syndrome (MPS), with myofascial trigger points (MTrPs) being its core feature [1]. MTrPs are characterized by a tender ‘contraction knot’ in a palpable taut band of muscle fibers that limits range of motion (ROM) [2,3]. In clinical practice, MTrPs can be classified into either latent or active [2]. Active MTrPs (A-MTrPs) cause spontaneous pain at rest with a referred pain pattern [4,5]. In contrast, latent MTrPs (L-MTrPs) cause pain only when compressed, but they are the root for functional changes, such as limitation of ROM [6,7].

Individuals with different characteristics may suffer from MTrPs, ranging from individuals who often participate in sports [8,9] to those who experience age-related degeneration [10,11] and orthopedic disorders [12,13]. Moreover, in newborn infants and young children, L-MTrP can be identified in some muscles after the age of 4 years [14,15]. As a result, the onset of MPS relies solely on the existence of L-MTrP [16].

Precipitating and perpetuating factors, including repetitive microinjuries, poor posture, overloading, and overuse of muscles, often heighten L-MTrPs, rendering them active [17]. Accumulating evidence supports a close relationship between motor dysfunctions and L-MTrPs [18]. Existing evidence demonstrates that L-MTrPs contribute to restrict joint ROM [19] and the development of muscle cramps. In addition, they induce a distorted activation pattern in a group of

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functionally related muscles during a motor task, leading to overuse and premature muscle weakness and accelerated fatigability [20].

It has been suggested that the treatment of L-MTrPs in pain-free individuals may not only decrease pain sensitivity and increase ROM but it also prevents their transformation into A-MTrPs, thereby preventing the development of chronic MPS [6]. A wide array of physical therapy approaches are used in eliminating MTrPs. Manipulative treatment [21], ultrasound, electrotherapy and thermotherapy [4,22], ‘spray and stretch’, ischemic compression and trigger point progressive pressure release (PPR) [2,23], strain and counterstrain [24], and needling therapies have been used in the management of MTrPs [25,26].

The two approaches of interest are PPR and trigger point dynamic deep dry needling (DDDN). Progressive pressure release uses a ‘press and stretch’ technique in its application by gradually increasing pressure on the MTrPs. It is an indirect technique that uses the barrier-release concept, in which the finger ‘follows’ the releasing tissue and restores abnormally contracted sarcomeres in the contraction knot to their normal resting length [2]. Moderately strong evidence supports the use of pressure release for immediate pain relief [27] and increase in ROM [28–33].

Deep dry needling is a therapeutic intervention advocated for inactivating MTrPs [2,34]. This technique varies: it may be applied in a slow, steady, lancing, or pistoning motion in and out of the muscle (termed dynamic needling), or may be left in place (termed static needling) [35]. It was suggested that dry needling is effective in reducing pain [36]. It is not known whether treatment effects of DDDN exceed those of PPR, as no studies were carried out to compare the two techniques on L-MTrPs. Therefore, the purpose of the current single-blinded randomized clinical trial was to compare the treatment effects of DDDN with PPR on pain pressure threshold (PPT) and cervical lateral flexion and rotation ROM in pain-free individuals with L-MTrPs in the upper trapezius muscle. It was hypothesized that there would be no significant difference between the two techniques in improving PPT and cervical lateral flexion and rotation ROM.

**Participants and methods**

**Design**
This single-blinded randomized trial was conducted at the out-patient clinic of the Faculty of Physical Therapy, Cairo University from December 2015 to April 2016.

**Sample**
We recruited 60 pain-free male and female participants, of whom 55 completed the study. Eligibility criteria were as follows: (i) age ranging from 20 to 30 years [37]; (ii) no neck pain over the preceding 3 months, but referred for treatment for other conditions; (iii) presence of more than two L-MTrPs in the upper trapezius, bilaterally; and (iv) limited cervical lateral flexion and rotation at the end of range (less than 40° and 70°, respectively) [38,39]. Participants were excluded if they exhibited any of the following criteria: (i) any type of neck pain or condition such as whiplash injury, previous cervical surgery, cervical radiculopathy, or myelopathy; (ii) previously undergone physical therapy interventions for the cervical spine in the last 3 months; (iii) fear of needles; or (iv) any contraindication for dry needling (e.g. anticoagulants or history of abnormal reaction to needling or injection).

Individuals were randomly assigned to one of the following two groups: the PPR group, which included 28 participants, and the DDDN group, which included 27 participants. In addition, both groups received passive stretch for the upper trapezius muscle, 3 sessions/week for eight consecutive weeks. PPT and active cervical ROM were assessed at baseline and 8 weeks after intervention. All participants signed an informed consent form before inclusion in the study. The study protocol was approved by the Board Council of Higher Education of the School of Physical Therapy, the Institutional Review Board of Higher Education and Research of Cairo University, and the Supreme Council of Universities in Egypt. The study is registered with the Australian New Zealand Clinical Trials Registry (ACTRN12616000902493).

**Myofascial trigger point identification and clinical examination**
All participants underwent a physical examination to determine the presence or absence of L-MTrPs in the upper trapezius, according to the allocations and standard clinical criteria defined by Simons et al. [2]. L-MTrP identification included the following: (i) exquisite tender nodule in a palpable taut band, and (ii) palpable or visible local twitch on pincer palpation. With the participant in prone position, flat and pincer palpation techniques were utilized wherein the upper trapezius muscle was placed in a slightly stretched-up position (lateral flexion and rotation to the opposite side) to lengthen and take up the slack of muscle fibers to widen the space within which MTrPs were easily
found. Figure 1 shows the location of L-MTrP1 present in the mid portion of the anterior border of the upper trapezius and involves the most vertical fibers that attach anteriorly to the clavicle, whereas L-MTrP2 was present caudal and slightly lateral to L-MTrP1, in the middle of the more nearly horizontal fibers of the upper trapezius [2].

To ensure intrarater consistency in finding the same L-MTrP bilaterally in the upper trapezius muscle, palpation was carried out three times on the identified site, locating the same L-MTrP every time in the identical spot each time. The examiner then marked the L-MTrP sites and documented them. If less than three nodules were identified bilaterally, palpation was continued until the examiner was satisfied that only two nodules were present in the muscle.

Interventions

Trigger point dynamic deep dry needling

Treatment was commenced with the participant positioned in a relaxed prone position with the head slightly flexed and rotated to the opposite side. The skin was disinfected and prepared with 70% isopropyl alcohol before needling. A pincer grip technique was used to gently lift the skin. DDDN was performed with a sterile, disposable, solid filament, stainless-steel needle (0.25 diameter×30 mm length; Suzhou Tianxie Acupuncture instruments, Suzhou, China) over the marked L-MTrPs. The needle was inserted in a 45° oblique angle, in an anterior–posterior direction, perpendicular to muscle fibers, to engage the whole L-MTrP, using a guide tube that was then removed [40] (Fig. 2). The depth of needle penetration was ∼10–15 mm, engaging into the L-MTrP so as to obtain a local twitch response. Once the first local twitch response was obtained, the needle was moved in a slow, steady, lancing, and pistoning motion, up and down in the muscle (5–7 mm vertical and oblique motions with no rotations) at ∼1 Hz for 30–60 s [40]. Subsequently, the needle was withdrawn, and the tissue was compressed for 10–30 s using a cotton swab to ensure adequate hemostasis.

Progressive pressure release

The participant was placed in a relaxed prone position, with the head slightly flexed and rotated to the opposite side to lengthen and take up the slack of muscle fibers. Steady pressure was applied, utilizing the thumb or knuckles, moving inward toward the center of marked L-MTrPs. Once tissue resistance was felt, the therapist held the pressure steady until tissue resistance dissipated. Once a ‘melting away’ sensation of the tissue was felt, further steady pressure moving again inward toward the center was applied (Fig. 3). PPR was applied for at least 30 s and up to 2 min at a time, and repeated 3–5 times [2]. Constant feedback was provided by the participant.

Passive stretch

Studies examining the efficiency of different manual treatment interventions for the management of MTrPs have utilized passive muscle stretching in multidisciplinary techniques [2,41]. Consequently, passive stretching of the upper trapezius muscle was also carried out for 60 s and repeated 3–5 times for both groups after DDDN and PPR (Fig. 4).

Adverse actions

Participants were asked to report any adverse action, pain, or soreness felt either after the intervention or during the 8-week intervention period. In our study, 22 participants in the DDDN group (81%) experienced postneedling soreness at the upper trapezius muscle.
To overcome this problem, we advised participants to apply cold packs if postneedling soreness occurred. Moreover, eight participants assigned to the PPR group (29%) experienced muscle tenderness at the upper trapezius after treatment. This naturally resolved within 24–48 h without any other intervention. Nevertheless, to be able to participate in the next session, participants were instructed to apply hot towels if muscle tenderness occurred [2].

Outcome measure
The primary outcome measure was PPT over the L-MTrPs. To establish a gold standard reference, a handheld digital electronic algometer (Force 1 G-model FDI; Wagner Instruments, Greenwich, Connecticut, USA) was used on the marked sites to measure L-MTrP tenderness by determining the PPT value. The transducer probe was placed perpendicular over the L-MTrP, and pressure was exerted by pressing the transducer firmly downward. Participants were instructed to say ‘STOP’ when the sensation first changed from pressure to pain. The digital display gave the actual pressure applied at the site in kilogram-force (a metric unit of force, which is equal to 1 kg of mass multiplied by the standard acceleration of gravity; 9.80665 m/s²), representing the PPT value. The examiner recorded three consecutive measurements of PPT levels at intervals of 20 s, and the mean was considered in the analysis [42,43]. Furthermore, the intrarater reliability of the pressure algometer was assessed using the intraclass correlation coefficient (ICC). Three measurements using the pressure algometer on the upper trapezius muscles were recorded by the same examiner on 10 participants on three different occasions.

The secondary outcome measure included active cervical lateral flexion and rotation, which was assessed using an inclinometer device (Baseline Bubble Inclinometer; Fabrication Enterprises Inc., White Plains, New York, USA). For active cervical lateral flexion, participants were made to sit with the head in neutral position and the inclinometer placed on the topmost part of the head, set at zero. Participants were instructed to bring their ear to shoulder. For active cervical rotation, participants were made to lie supine with their head in neutral position and the inclinometer placed on the center of the forehead, set at zero. Again, participants were instructed to bring their chin to shoulder [38,39]. For each movement, two trials were recorded and the mean was used in the analysis. ROM was recorded in a standard sequence: right/left lateral flexion, and right/left rotation.

Sample size
The sample size was calculated using PASS 14 sample size software (Utah, USA). It was calculated by detecting a difference of 2.1 in PPT values from former studies, assuming a SD of 2.1, a two-tailed test, an α-level of 0.05, and an estimated power (β) of 90%. On the basis of these calculations, an estimated sample size was to be 22 participants per group [44]. Thirty participants per group were selected to account for dropouts.

Randomization
Following the baseline examination, participants were randomly assigned to receive either PPR or DDDN.
Randomization was performed using a computer-generated randomized table of numbers created before the start of data collection. Individual and sequentially numbered index cards were used to randomly assign participants to the treatment groups. The index cards were folded and placed in sealed, opaque envelopes. Each participant was given a hand-picked envelope and proceeded with treatment according to the group assignment.

**Blinding**
A blinded investigator to the examination and treatment procedure implemented the random allocation sequence and enrolled participants to the intervention groups. The physical examination and data collection (at baseline and after the 8-week intervention period) were carried out by a single blinded (to treatment allocation), qualified, and certified manual physical therapist with more than 7 years of experience in the management of MTrPs. Finally, a certified physical therapist in acupuncture and dry needling with more than 10 years of experience carried out the DDDN technique. However, a second certified physical therapist in manual therapy with more than 8 years of experience carried out the PPR and passive stretch techniques. Both therapists delivering the treatment were blinded to the examination, sequence allocation, and data collection of participants.

**Data analysis**
Statistical analysis was computed using IBM SPSS Statistics 21.0 software. Descriptive statistics were used to describe the means and SDs of the participants’ characteristics. The independent *t*-test and paired-samples *t*-test were used for comparison within and between groups. The level of significance was set at *P* value of 0.05 or less. The ICC test was used to measure the intrarater reliability of the pressure algometer.

**Results**
Table 1 lists the general physical characteristics of the 55 participants in our study. Five participants (two from the PPR group and three from the DDDN group) dropped out from the study and their data were excluded from the analysis. A total of 182 L-MTrP sites were evaluated using the electronic digital algometer. The ICC for intrarater reliability of the pressure algometer on upper trapezius was 0.96, which indicates high reliability. Within-group comparison showed a significant improvement in PPT values, active lateral flexion, and rotation ROM before and after treatment (*P*<0.001). Substantial difference was found using the paired *t*-test, in which the percentage of increase in PPT values in the PPR group (79.76%) was higher than that in the DDDN group (31.92%). Average PPT repeated measures and between-group measurements are listed in Table 2. Furthermore, Table 3 presents the comparison of active lateral flexion and rotation between the two groups, wherein it was significantly higher in the PPR group compared with the DDDN group (*P*<0.006 and 0.027, respectively).

**Discussion**
The results of this current study suggest that both the PPR and DDDN techniques were effective in improving PPT values and active cervical lateral flexion and rotation. However, on comparing the two groups, PPR showed to be more effective compared with the DDDN technique during the 8-week intervention period. One explanation might include that 81% of participants experienced postneedling soreness that lasted for 2–5 days, longer than that for PPR tenderness that subsided within 24–48 h. Hong [40] faced the same difficulty in his study, in which 100% of patients receiving dry needling suffered from postneedling soreness. This soreness is significantly greater in intensity and duration compared with the tenderness in PPR (29% of participants).

These findings are in agreement with the findings of Fryer and colleagues, who investigated the effect of PPR for sixty seconds on cervical pain and ROM. They
found a significant immediate decrease in the sensitivity of MTrPs and a significant increase in cervical ROM [41]. Simons [3] advocated that MTrP progressive pressure release is best applied as a painless but uncomfortable barrier release technique. Hence, applying PPR was less painful compared with DDDN. This was well approved by participants in the PPR group (group A) in which only 29% of patients experienced some pain after PPR application that lasted for 1 day, and hence increases ROM and PPT.

Manual therapies were found to have specific efficacy in increasing PPT and restricted ROM as well as reducing scores on visual analogue scales [45]. This is in contrast to the findings of Hou and colleagues, who suggested that PPR produces only immediate relief from pain. They concluded that the combination of hot packs, ROM exercise, stretch with spray, interferential current, and myofascial release provided better effect in reducing pain and in increasing cervical ROM. However, the follow-up in this study lasted just for 5 min after treatment [28].

Muscle fibers respond to trauma or abnormal stress by releasing calcium from the sacroplasmic reticulum or through injured sacrolemma, which in return causes uncontrolled contraction activity and increased metabolism. This sustained muscle contraction decreases blood supply, leading to an accumulation of waste products and eventual muscle fatigue, evoking nociceptors that induce pain. This promotes a self-perpetuating circle; shortening of the muscle disposed to the loss of sarcomeres. Later, increasing the proportion of the collagen in the muscles contributes to the aggravation of pain and muscle stiffness, consequently decreasing active ROM [23].

Gradual pressure applied downward tends to release and break down collagen fibers in the contracted sarcomeres of the affected muscle fibers. This equalizes the length of sarcomeres. Subsequently, the palpable knot decreases and muscle fiber length increases, thus increasing functional ROM [23]. However, this was not the case with DDDN application, in which PPR on L-MTrPs seemed to be more effective in increasing active cervical lateral flexion and rotation in the current study.

Progressive pressure release may resolve the problem itself by regaining the normal length of sarcomere, whereas DDDN may only cause an analgesic effect through the elevation of opioid peptides in the central nervous system and diffusing the noxious inhibitory control system that adjusts the pain-originating area [46]. Inserting a needle into the MTrP and stimulating it by pistoning is thought to decrease pain due to the rapid depolarization of the involved muscle fibers, which manifests as local twitches. After the muscle has finished twitching, the spontaneous electrical activity subsides and the pain decreases dramatically [47].

Our findings are in contrast to those of Ramos and colleagues, who suggested that two sessions of trigger point dry needling or trigger point manual therapy

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### Table 2 Within and between group comparison of pressure pain threshold values (kgf)

<table>
<thead>
<tr>
<th>t-Test</th>
<th>Within group</th>
<th>Between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PPR group (n=28)</td>
<td>DDDN group (n=27)</td>
</tr>
<tr>
<td>Pretreatment</td>
<td>5.83±0.87</td>
<td>5.67±0.90</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>10.48±1.21</td>
<td>7.48±0.93</td>
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</tbody>
</table>

*P<0.01=highly significant. **P>0.05=not significant.

Data are expressed as mean±SD. CI, confidence interval; DDDN, dynamic deep dry needling; PPR, progressive pressure release.

### Table 3 Within and between group comparison of cervical lateral flexion and rotation (angular degree)

<table>
<thead>
<tr>
<th>t-Test</th>
<th>Within group</th>
<th>Between groups</th>
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<tbody>
<tr>
<td></td>
<td>Lateral flexion</td>
<td>Rotation</td>
</tr>
<tr>
<td>Pretreatment</td>
<td>38.80±3.95</td>
<td>77.33±7.37</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>43.87±3.98</td>
<td>83.93±4.59</td>
</tr>
</tbody>
</table>

*P<0.001=highly significant. **P>0.05=not significant.

Data are expressed as mean±SD. CI, confidence interval; DDDN, dynamic deep dry needling; PPR, progressive pressure release.

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resulted in similar outcomes in terms of pain and disability in patients with chronic mechanical neck pain, after the intervention and at a 2-week follow-up. However, they identified greater improvements in PPT values over active MTrPs in those patients receiving trigger point dry needling [44].

An explanation may include that DDDN of MTrPs may elicit the phenomenon of referred pain in active MTrPs [48]. However, even when needling L-MTrPs, all participants in the current study experienced discomfort and referred pain during and after the treatment. This demonstrates that DDDN activates the L-MTrPs. Xu and colleagues found a decrease in mechanical pain threshold several minutes after needle insertion of L-MTrP in healthy patients. It was postulated that mechanical stimulation of L-MTrPs induces centrally mediated referred pain, thus having the potential to induce central sensitization [49].

**Limitations and generalizability**

Clinical identification was based on palpation and Simons et al.’s [2] essential and confirmatory criteria of L-MTrPs. Although these are the reference standards for detecting and classifying MTrPs, they are still considered to be subjective measures. To quantitatively determine MTrPs tenderness, we used PPT scores. However, this utilizes the perception of what each study participant determines the pain threshold to be. Furthermore, we used PPR and DDDN individually, not demonstrating multimodal approaches in actual clinical practice. Our study lacked a control group, and hence we cannot ascertain whether the groups improved because of the intervention or as a result of other variables. Hence, universal generalization is still premature.

Future work needs to focus on the efficacy of PPR and DDDN collectively in multimodal approaches for the management of MPS. We also recommend that future trials include a control group and data be collected repeatedly at multiple intervals of time along the intervention and follow-up period.

**Conclusion**

Within the scope of our study, we conclude that PPR technique have been considered to be more effective compared with DDDN in the management of cervical L-MTrPs, in terms of pain sensitivity and ROM.

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**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/ her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

**Conflicts of interest**

There are no conflicts of interest.

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**References**


