Journal of Bodywork & Movement Therapies 24 (2020) 7–12

Contents lists available at ScienceDirect

Journal of Bodywork & Movement Therapies

journal homepage: www.elsevier.com/jbmt

Myofascial Pain and Treatment

Day of peak pain reduction by a single session of dry needling in the upper trapezius myofascial trigger points: A 14 daily follow-up study

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ARTICLE INFO

Article history:
Received 23 July 2019
Received in revised form
18 May 2020
Accepted 7 June 2020

Keywords:
Pain
Dry needling
Myofascial trigger points
Upper trapezius muscle

ABSTRACT

Background: Dry needling (DN) is commonly used to inactivate myofascial trigger points (MTrPs). However, a daily report of pain reduction has not been determined.
Objective: The aim was to evaluate the time of the greatest pain relief after performing a single session of DN in MTrPs of the upper trapezius muscle.
Methods: A patient who had MTrPs in the upper trapezius muscle was enrolled into a prospective descriptive study. Each patient received a single session of DN, using a fast-in-fast-out technique, with needle retention for 30 min. Numerical rating scale (NRS) scores were collected daily for 14 days. The mean difference of pain and an effect size were calculated. The 1–5 satisfaction score was a secondary outcome.
Results: Sixty-seven subjects completed the intervention. The mean duration of the symptom was 27.32 months. The mean baseline NRS score was 5.30. The pain decreased significantly between immediate post-procedure and 1 day after the DN treatment from 5.16 to 3.40 (mean difference 1.76, $p < 0.01$, effect size = 0.87). The pain continuously reduced until day 10 and then it gradually rose. The pain on day 10 was compared with the baseline that revealed the largest effect size of 3.08 (mean difference 4.67, $p < 0.01$). Eighty-eight percent of the subjects were very satisfied with their treatment.
Conclusions: A single session of DN treatment in the upper trapezius MTrPs combined with self-stretching exercises could greatly reduce pain between immediate post-procedure and 1 day after DN treatment. The peak effect on pain reduction occurred on day 10.

1. Introduction

Myofascial pain syndrome (MPS) is a common form of pain that arises from muscles or related fascia. It is usually associated with myofascial trigger points (MTrPs) which are highly localized, hyperirritable spots in a palpable, taut band of skeletal muscle fibers (Simons et al., 1999). Simons (2004) hypothesized that palpable taut bands in the affected muscles are due to excessive acetylcholine release at the neuromuscular junction (motor endplate). In this situation, a continuous contraction of the muscle fibers, which is accompanied by increased metabolism and local ischemia, leads to increased secretion of sensitizing substances and can subsequently cause pain and autonomic reactions such as increased sweating, vasoconstriction or vasodilation, and pilomotor activity in the muscle (Ge et al., 2006; Dommerholt and Huijbregts, 2010).

MPS was also described as a common cause of pain in clinical practice (Simons, 2002; Borg-Stein and Simons, 2002). The prevalence of MPS was 36% of patients suffering from skeletal and muscle abnormalities (Simons et al., 1999; Fernandez-de-las-Penas et al., 2007). According to a study by Phumiphithakkun et al. (2002), patients who presented with neck, upper back, and scapular pain were commonly diagnosed with MPS and MTrPs in the upper trapezius muscle. MPS is a major problem that adversely affects the quality of life of patients (Celiker et al., 2010).

Dry needling (DN) has been traditionally used as one of the fastest and most-effective ways to inactivate MTrPs and help alleviate the pain. The needle is placed into the MTrPs using an in-and-out technique in multiple directions, in order to inactivate the MTrPs (Desai et al., 2013). The physiological mechanism of DN is intensely complex. It consists of both central and peripheral

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https://doi.org/10.1016/j.jbmt.2020.06.040
1360-8592/

networks with various physiologic and psychological responses such as mechanical disruption of the integrity of dysfunctional endplate, increased muscle blood flow and oxygenation, release of endogenous opioids, segmental inhibition and gate control, the effectiveness on release of serotonin and noradrenaline, remote effect, and the placebo effect (Cagnie et al., 2013).

Many randomized controlled trial and meta-analysis studies were conducted to establish the advantage of DN in MPS treatment, especially pain reduction. A systematic review conducted by Liu et al. (2015) revealed that DN should be recommended to relieve MTrP pain in the neck and shoulder in both the short term and medium term. However, each study in this review measured the outcomes in different periods that varied from immediate post-procedure to 3 days, 1 week, 2 weeks, and up to 24 weeks after the intervention. None of the studies reported the daily effectiveness in the short term on pain reduction after performing DN. Therefore, this study aimed to determine pain reduction in each day for 14 days and establish the time of the peak effect after a single session of DN with needle retention for 30 min on MPS in the upper trapezius muscle.

2. Methods

2.1. Study population

This was a prospective descriptive study. The patients were consecutively recruited over a 5-month period between April and August 2018. The inclusion criteria were; patients between 18 and 70 years old, presence of MPS with active MTrPs in the upper trapezius muscle. MPS was diagnosed according to Travell and Simons criteria (Simons et al., 1999). Major criteria are: (1) regional pain, (2) a taut band, (3) exquisite tenderness on the taut band, (4) referred pain and (5) restricted range of motion. Minor criteria are: (1) reproduction of pain, (2) local twitch response and (3) pain relief with injection or stretching. All five major criteria and at least one minor criteria were required. An active MTrPs was defined as a MTrP that causes a clinical pain complaint. It is always tender, prevents full lengthening of the muscle, weakens the muscle, refers a patient-recognized pain on direct compression, mediates a local twitch response of muscle fibers when adequately stimulated and when compressed within the patient's pain tolerance, produces referred motor phenomena and often autonomic phenomena, generally in its pain reference zone and causes tenderness in the pain reference zone (Simons et al., 1999). Patients were excluded in case of having a history of fibromyalgia, whiplash injury, cervical spine fracture or surgery, cervical radiculopathy, or any systemic disease such as rheumatism, tuberculosis, or multiple sclerosis. Patients were excluded if they had a contraindication for needling such as local infection, pregnancy, coagulopathy or taking anticoagulants. In addition, patients were also excluded if they had undergone MTrPs therapy, such as oral or topical medications, local injection, needle therapy, physical modalities, or manual therapy within the previous month prior of the study.

The previous meta-analysis revealed that DN was effective in both the short term; immediate to 3 days after a final treatment, and a medium term; 9–28 days after the last treatment (Liu et al., 2015). However, the day in which the greatest pain reduction occurred was not identified. Therefore, the sample size was calculated based on the assumption of a peak reduction in pain intensity, measured by a numerical rating scale (NRS) score at day 7. This was between a short and medium term period with an estimated standard deviation (σ) of 4 days. Furthermore, we assumed an alpha level of 0.05, with a 95% confidence level ($Z^2_{1-\alpha/2}$) being 1.96. A desired precision (d) was 1 day. All numeric values were replaced in a sample size formula: $Z^2_{1-\alpha/2}\ \sigma^2/d^2$ (Daniel, 1994). This calculation generated a sample size of at least 62 subjects. In case of a 10% dropout, the final number of subjects was 69.

The study was approved by the Human Research Ethics Committee (HREC) of the Faculty of Medicine at Prince of Songkla University (number REC: 60-451-11-1).

2.2. Intervention

The patients who fulfilled the inclusion criteria were informed of the research study and signed an informed consent before attending the study. The basic demographic data, that included age, gender, occupation, duration of symptom, and side of active MTrP, were recorded.

Active MTrPs was determined by a patient reporting clinical pain on the upper trapezius muscle. The second author (P.U.) then examined a taut band within the muscle, the anterior and vertical fibers, by a pincer grasp. The muscle belly was lifted off and rolled between the thumb and fingers to palpate the taut band (Finnegan and Fernandez-de-las-Penas, 2019). It was defined as the most painful active MTrPs when this direct compression on the taut band of the upper trapezius muscle produced a patient-recognized pain, a local twitch response and a referred pain in its reference zone (Simons et al., 1999). All subjects received only a single session of DN of the most painful active MTrPs found in the upper trapezius muscle by the second author using a 0.25 $\times$ 25 mm acupuncture needle (Maanshan Bond Medical Instruments Co., Ltd. China). DN was performed in the sitting position. The skin was prepared using 70% alcohol. Hong's technique, which is a fast-in-fast-out needling method, was performed (Hong, 1994). The needle penetrates the taut band and is removed to the superficial tissue, but not out of the skin, and then redirected to another area of active MTrP. Once the needle was inserted to the MTrPs, local twitch responses (LTRs) were obtained. After 4–5 LTRs, the needle was retained for 30 min according to traditional Chinese medicine acupuncture technique (Shi et al., 2012; Dunning et al., 2014). Acupuncture studies have shown that needle retention had an effect on the pain threshold, and it also had a pain-relieving effect (Hsiu et al., 2009; Shi et al., 2012). Therefore, a combination of both a western and eastern needling procedure was designed in this trial. Finally, the needle was withdrawn after needle retention was completed and the area was again disinfected by 70% alcohol. The vital signs and clinical status, including any complications; such as post-needling soreness, bleeding, ecchymosis, syncope, dizziness, pneumothorax and others were recorded before and after the DN session.

All subjects were advised to follow the self-stretching exercises of the upper trapezius muscle, postural correction, including ergonomic modifications. The starting position of the self-stretching was sitting. A ipsilateral hand grabbed onto a bottom or back of a seat. Then a contralateral hand held the head and slowly tilted the head forward, with lateral bending to the opposite side, until the patient felt a gentle stretch along the side of the neck and shoulder. Patients needed to hold this stretch for 10 s, then it was repeated 10 times, per set; with two sets a day. Patients who had rounded shoulder posture or excessive forward head posture was recommended to correct. Workplace stations were also considered as well; wherein, the computer screen should be set in front of the body, with two-thirds of the screen below eye level. Both keyboard and a mouse should be placed at an appropriate height, allowing the elbows and shoulders to be relaxed at 90°. A chair with a proper height of armrests was helpful to support both forearm and the elbow positioning. Leaning against a backrest, to relax the upper trapezius muscle, was also suggested (Finnegan and Fernandez-de-las-Penas, 2019).

The only permitted rescue analgesic was paracetamol. Other analgesics, such as nonsteroidal anti-inflammatory drugs, muscle

relaxants, benzodiazepines, tramadol, and antidepressants had been reported as to the efficacy in MPS (Borg-Stein and Iaccarino, 2014). Therefore, these analgesics possibly confounded the pain measurement in the study. Once a patient had intolerable pain and paracetamol could not relieve a symptom, other drugs were able to be taken; however, then the patient would be eventually excluded from the study. In addition, the subjects were instructed to cease all non-pharmacological treatment such as massage, physical modalities, and manual therapy during the study period.

2.3. Outcome measurement

The main outcome was pain intensity reduction measured by a 0–10 NRS where 0 represented 'no pain' and 10 represented 'worst imaginable pain'. It was recorded at baseline, immediately after the DN and on each day from the first day to the fourteenth day post-DN. A total of 16 measurements were recorded. The greatest effect size that was calculated by the difference in the NRS score and standard deviation between baseline and each time point represented the peak pain reduction effect of DN. While the greatest effect size between each consecutive day represented the best pain reduction period over 24 h. The NRS was recorded by a daily telephone call in order to determine pain intensity on each day. The secondary outcome was the 1–5 satisfaction score measured at day 14 after DN where 1 represented 'very unsatisfied' and 5 represented 'very satisfied'.

2.4. Statistical analysis

Descriptive statistics for continuous variables are presented as mean and standard deviation (SD) and categorical variables are presented as numbers and percentages. Within-group changes in the NRS or mean pain difference between a baseline and each time point and between days were calculated using repeated measures analysis of variance (repeated ANOVA). Cohen effect size was used to measure the magnitude of the treatment effect. Effect sizes of 0.2, 0.5, and 0.8 are generally interpreted as small, medium, and large changes respectively (Kazis et al., 1989). A p value < 0.05 was considered statistically significant. The R software version 3.5.1 was used for the statistical analysis.

3. Results

A total of 69 patients were initially recruited. However, two patients were withdrawn from the research, because one developed dizziness then they decided to terminate the study, and the other was lost to follow-up. Finally, 67 subjects completed the intervention and were analyzed. Table 1 shows the baseline demographics. The patients had a mean age of 37.37 years old. The mean pain duration was 27.32 months. Mostly subjects were female. The mean NRS scores at baseline, immediately post-DN and during the 14 days post-DN are shown in Fig. 1. The mean NRS score at baseline was 5.30. The mean immediate NRS score at post-procedure minimally decreased to 5.16. After that, the NRS score showed on-going reduction until day 10. Then the NRS score gradually increased.

The results of repeated ANOVA to compare the NRS change in scores between the baseline and each time point are given in Table 2. The effect size to assess the clinical effectiveness at each time point is also presented. It was considerably the greatest on day 10 post-DN (mean difference = 4.67, effect size = 3.08, $p < 0.01$). The mean NRS score differences between each consecutive day post-DN are shown in Table 3. The greatest effect size was found between immediate post DN procedure and day 1 (mean difference = 1.76, effect size = 0.87, $p < 0.01$).

Table 1
Demographic data of the 67 subjects.

Demographic data	Values
Age (years), mean ± SD	37.37 ± 11.38
Sex, n (%)	
Male	9 (13%)
Female	58 (87%)
Occupation, n (%)	
Office worker	31 (46%)
Healthcare provider	25 (38%)
Student	3 (5%)
Lecturer	2 (3%)
Merchant/Self-employed	2 (3%)
Un-employed	2 (3%)
Others	1 (2%)
Pain duration (months), mean ± SD	27.32 ± 26.62
Side of MTrP, n (%)	
Right upper trapezius muscle	17 (25%)
Left upper trapezius muscle	13 (20%)
Both sides	37 (55%)
Baseline NRS, mean ± SD	5.30 ± 1.71

SD, standard deviation; *n,* number; *MTrP,* myofascial trigger points; *NRS,* numerical rating scale.

The satisfaction score revealed that 88% of the subjects gave 5 points which indicated they were very satisfied with the DN treatment. The remaining subjects reported 4 points (satisfied) and 3 points (neutral) for 9% and 3% of the subjects, respectively. Other complications of the DN, except for one who had dizziness, did not occur in any patient during the study period. No one took paracetamol or other analgesics during the study.

4. Discussion

To our knowledge, this is the first study on the effect of DN from a daily recording of pain intensity to obtain the peak effect and the greatest effectiveness during the pain reduction period after a single session of DN. The results of this study indicated that the greatest change of pain was determined by the greatest effect size that appeared on day 10 post-DN which represented the peak pain reduction effect. However, it was also found that the period between immediate post-DN to the next day had the greatest significant pain reduction compared with any other two consecutive days.

The results of this study revealed that the peak effect of pain reduction was on day 10, while many studies published the effectiveness in pain reduction with different study protocols and follow-up periods (Liu et al., 2015; Dommerholt, 2011; Gattie et al., 2017). A systematic review of Kietrys et al. (2013) concluded that DN for immediate pain reduction in the patients with upper quarter MPS was recommended while DN for reduction of pain at 4 weeks was cautiously recommended. The result of a study by Liu et al. (2015) was similar. They revealed that DN could be tentatively recommended to relieve MTrPs pain at the neck and shoulder in the short and medium term compared with a control or sham study group. The results of a study by Huang et al. (2011), showed that the worst pain intensity and average pain intensity decreased from pretreatment levels at every time point (i.e. 2, 4, and 8 weeks) and the greatest effect size was found in the first 2 weeks. These were consistent with our study. The mechanism was probably explained by the needle effect on MTrPs. The contraction knots that formed at the MTrPs were located in the dysfunctional motor endplates. Domingo et al. (2013) proved that multiple insertions of dry needling in the endplate zone of mice muscles caused an injury that resulted in mechanical damage to the muscle fiber and the motor endplates. The healing process proceeded by complete

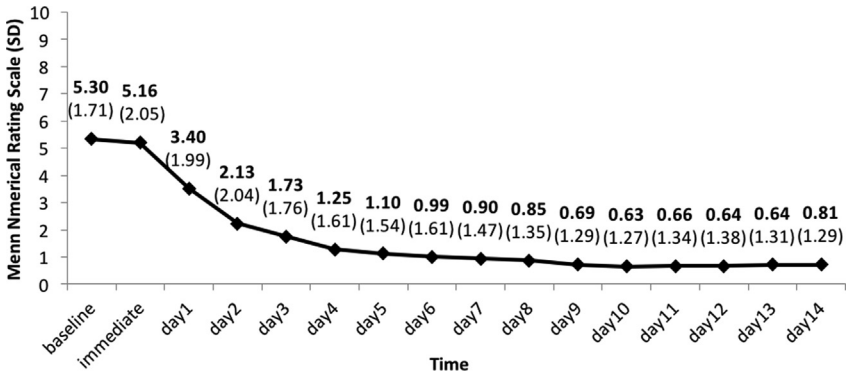

Fig. 1. Mean and standard deviation (SD) of numeric rating scale pain score at each time point after dry needling.

Table 2
Mean difference and effect size of numerical rating scale (NRS) between baseline and each day after dry needling.

NRS comparison	Mean difference ± SD	Effect size (95%CI)
Baseline to Immediate	0.14 ± 1.89	0.07 (−0.27–0.41)
Baseline to Day1	1.90 ± 1.86*	1.02 (0.66–1.38)
Baseline to Day2	3.17 ± 1.88*	1.67 (1.28–2.07)
Baseline to Day3	3.57 ± 1.74*	2.05 (1.63–2.46)
Baseline to Day4	4.05 ± 1.65*	2.45 (2.00–2.89)
Baseline to Day5	4.20 ± 1.63*	2.57 (2.11–3.02)
Baseline to Day6	4.31 ± 1.66*	2.58 (2.12–3.04)
Baseline to Day7	4.40 ± 1.59*	2.74 (2.27–3.22)
Baseline to Day8	4.45 ± 1.54*	2.87 (2.39–3.35)
Baseline to Day9	4.61 ± 1.51*	3.03 (2.53–3.52)
Baseline to Day10	4.67 ± 1.51*	3.08 (2.58–3.58)
Baseline to Day11	4.64 ± 1.54*	3.00 (2.51–3.50)
Baseline to Day12	4.66 ± 1.55*	2.98 (2.49–3.47)
Baseline to Day13	4.66 ± 1.52*	3.04 (2.54–3.54)
Baseline to Day14	4.49 ± 1.51*	2.95 (2.46–3.44)

SD, standard deviation; *CI*, confidence interval. *p value < 0.01.

Table 3
Mean difference and effect size of numerical rating scale (NRS) between each 2-consecutive days after dry needling.

NRS comparison	Mean difference (SD)	Effect size (95%CI)
Baseline to Immediate	0.14 ± 1.89	0.07 (−0.27–0.41)
Immediate to Day1	1.76 ± 2.02*	0.87 (0.51–1.22)
Day1 to Day2	1.27 ± 2.02*	0.63 (0.28–0.97)
Day2 to Day3	0.40 ± 1.91	0.21 (−0.13–0.55)
Day3 to Day4	0.48 ± 1.67	0.29 (−0.05–0.63)
Day4 to Day5	0.15 ± 1.56	0.10 (−0.24–0.43)
Day5 to Day6	0.11 ± 1.58	0.07 (−0.27–0.41)
Day6 to Day7	0.09 ± 1.54	0.06 (−0.28–0.40)
Day7 to Day8	0.05 ± 1.41	0.04 (−0.30–0.37)
Day8 to Day9	0.16 ± 1.32	0.12 (−0.22–0.46)
Day9 to Day10	0.06 ± 1.28	0.05 (−0.29–0.39)
Day10 to Day11	−0.03 ± 1.31	0.02 (−0.36–0.32)
Day11 to Day12	0.02 ± 1.36	0.02 (−0.32–0.35)
Day12 to Day13	0.00 ± 1.35	0.00 (−0.34–0.34)
Day13 to Day14	−0.17 ± 1.30	0.13 (−0.47–0.21)

SD, standard deviation; *CI*, confidence interval. *p value < 0.01.

regeneration in 3 and 7 days for neuromuscular and muscular injury, respectively. This implied that the pain reduction properties in humans might mimic these mechanisms in the animal model. The damaged neuromuscular area needed an entire revival of at least 7 days. Therefore, a significant peak pain reduction would appear after that. Although the mean NRS score tended to increase after day 10, the pain relieving effect still remained. The mean NRS score on day 14 was above the minimal clinical importance difference. It was considered by a NRS change score of −2.0 and a percent change score of −33.0% which were the best associations with the concept of "much better" improvement (Salaffi et al., 2004).

The present study also found that the greatest pain reduction occurred between immediate post-procedure and 1 day after the DN. Previous studies that compared the effect of a single session of DN in the upper trapezius versus a control group had similar results. A significant improvement in pain was reported to be immediately after treatment using an 11-point NRS for pain (Mejuto-Vázquez et al., 2014; Llamas-Ramos et al., 2014). The immediate pain reduction could be explained by two main mechanisms. The first consideration is the potential mechanical pathways whereby the contraction knot is disrupted with an increase in the sarcomere length. Second, the neurophysiological effects, which are predicted by the gate control theory, decrease peripheral nociception with involvement of the endogenous opioid system (Cagnie et al., 2013; Baldry, 2005). In addition, a reaction from the DN on the autonomic nervous system should also be considered. Some patients had autonomic symptoms in the affected muscles due to the sympathetic dysfunction (Simons et al., 1999). Abbaszadeh-Amirdehi et al. (2017) reported that a single session of DN immediately reduced sympathetic skin response amplitude and pain intensity. The pathway probably resulted from needle stimulation of the Aδ afferent fibers. Then it modulated the higher brain centers to induce an inhibitory effect on the autonomic nervous system. Finally, pain related to an autonomic dysfunction was suddenly minimized.

Considering the complications, there was no subjective report of post-needling soreness during the study. Post-needling soreness is totally different from the pain resulted from MTrPs. Post-needling soreness is defined as constant pressure or dull aching, while the original myofascial pain is sharp and tight aching (Hong, 1994). The soreness and myofascial pain should be measured separately. However, the soreness could mask the original myofascial pain, and influence a patient's myofascial pain ratings (Martín-Pintado-Zugasti et al., 2018a). Some previous research reported a presence of post-needling soreness. Ferna'ndez-Carnero et al. (2017) found that post-needling soreness was observed in a high proportion of pain patients after DN of MTrPs in the neck region, in 91.4% of the subjects. The clinical relevance of persistent post-needling soreness is uncertain, but it is related to reduced treatment adherence (Pérez-Palomares et al., 2010). A recent, randomized controlled trial by Martín-Pintado-Zugasti et al., 2018b disclosed that the study group, in which DN was performed that elicited LTRs, exhibited a greater prevalence of post-needling soreness and intensity than the control group. Simons et al. (1999) mentioned various ways to prevent, or relieve post-needling soreness such as moist heat,

stretching, and application of pressure on the MTrPs. In this study, manual pressure was applied to the upper trapezius muscle to identify the MTrPs, prior to DN, and all patients were instructed to complete home self-stretching exercises. Therefore, post-needle soreness possibly faded away.

This study has some limitations. First, most subjects had duration of neck pain for more than one year which indicated chronic MPS. Therefore, the results of this study may not be implied for acute stage of active MTrPs. Second, different techniques of needle therapy, other than those used in this study, might not show the same effectiveness. Therefore, further research to explore these issues are needed.

5. Conclusion

The peak effect on pain reduction by a single session of DN with retention for 30 min combined with self-stretching exercises in the upper trapezius MTrPs occurred on day 10 after the procedure, and there was a sharp pain difference between immediate post-procedure and day 1 after the DN treatment. These findings are useful when informing the patient of the DN technique.

Clinical relevance

- A single session of DN with needle retention for 30 min in the upper trapezius MTrPs resulted in the greatest pain relieve on day 10.
- The maximum sharp pain difference by the intervention appeared between immediate post-procedure and day 1.
- Most patients were very satisfied with this procedure.
- Future studies to compare the effectiveness between this technique and a group of standard care, stretching exercises only, should be considered.

Funding

The present study was supported by grants from the Faculty of Medicine, Prince of Songkla University, Thailand.

CRediT authorship contribution statement

Phichamon Khanittanuphong: Conceptualization, Formal analysis, Funding acquisition, Methodology, Supervision, Validation, Visualization, Writing - review & editing. **Phichaporn Upho:** Data curation, Formal analysis, Investigation, Software, Visualization, Writing - original draft.

Declaration of competing interest

None of the authors has any conflict of interest to disclose.

Acknowledgments

The authors would like to thank Jirawan Jayuphan who is a statistician consultant in the Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Thailand.

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