Water-Diluted Local Anesthetic for Trigger-Point Injection in Chronic Myofascial Pain Syndrome: Evaluation of Types of Local Anesthetic and Concentrations in Water

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Background and Objectives: We have recently demonstrated that a mixture of 1% lidocaine with water in a 1:3 ratio has less injection pain and is more effective than unaltered 1% lidocaine in treating chronic myofascial pain syndromes. Yet, the most suitable local anesthetic and the most effective dilution in water have not been evaluated.

Methods: Various mixtures of local anesthetics and water or saline were injected intramuscularly into the shoulder of 40 female volunteers, and pain scores on injection were evaluated in a randomized and double-blinded manner. In another portion of the study, 0.25% or 0.2% lidocaine in water were injected randomly into 1 side of 21 outpatients with chronic neck, shoulder, or lumbar myofascial pain to the same degree in both sides. The other solution was injected into the other side of the same patients.

Results: Less injection pain was experienced with the water-diluted 0.25% lidocaine and water-diluted 0.25% mepivacaine than the saline-diluted 0.25% lidocaine and water-diluted 0.0625% bupivacaine. Also, less injection pain was experienced with the water-diluted 0.25% and 0.2% lidocaine than the water-diluted 0.3% and 0.15% lidocaine. In the other study, there were no differences in either the effectiveness or duration of analgesia between the 0.25% and 0.2% water-diluted lidocaine.

Conclusions: The suitable type of local anesthetic may be lidocaine or mepivacaine, and the most effective water-diluted concentration is considered to be 0.2% to 0.25%. *Reg Anesth Pain Med 2001;26:333-336.*

Key Words: Myofascial pain syndrome, Trigger-point, Intramuscular injection, Local anesthetic, Water, Saline.

Chronic myofascial pain syndromes are commonly found in the neck, shoulder, or low back regions, and in these areas trigger-points have commonly been treated with injection of various local anesthetics into the trigger-points.[1] Other treatments, for trigger points include dry needling[2] or saline injection,[3] and it is unclear whether they are superior to local anesthetic injection.[1,4,5] Additionally, injection of sterile distilled water has been reported to be more effective than that of local anesthetics,[6-9] but this has not been widely applied because of the severe pain on injection. Recently, we demonstrated that a mixture of a commercially available 1% lidocaine with water in a ratio of 1:3 causes almost no injection pain and is more effective than unaltered 1% lidocaine in treating chronic myofascial pain syndromes.[10] However, the most effective local anesthetic and the ideal concentration in water have not yet been evaluated. In this report, we designed further experiments to elucidate these questions.

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Methods

This study was approved by the institutional human investigation committee of our hospital, and all adult, healthy volunteers, who were nursing personnel of the hospital or outpatients consulting our pain clinic, gave informed consent.

Evaluation of Types of Local Anesthetic and Water-Diluted Concentrations

Twenty female volunteers were studied. Mixtures of 0.5 mL 1% lidocaine (AstraZeneca, Osaka,

Japan) and 1.5 mL water (water-diluted 0.25% lidocaine), 0.5 mL 1% lidocaine and 1.5 mL saline (saline-diluted 0.25% lidocaine), 0.5 mL 1% mepivacaine (AstraZeneca) and 1.5 mL water (water-diluted 0.25% mepivacaine), and 0.5 mL 0.25% bupivacaine (AstraZeneca) and 1.5 mL water (water-diluted 0.0625% bupivacaine) were prepared. Both shoulders of each volunteer were used and randomly divided into 4 groups of 10 shoulders each. After disinfecting the skin at the suprascapular region with an alcohol swab, 2 mL of test solution was injected intramuscularly by the same investigator into the trapezius muscle using a 25-gauge needle in a double-blind manner. For each injection, the subjects were asked to grade the pain score of injection as: no pain = 1; mild pain = 2; moderate pain = 3; and severe pain = 4.

Twenty female volunteers were used in the additional study. One percent lidocaine was diluted in water to obtain the water-diluted 0.3%, 0.25%, 0.2%, and 0.15% lidocaine. Both shoulders of each volunteer were included and randomly divided into 4 groups of 10 shoulders each. Intramuscular injections of 2 mL of test solution were given as earlier described, pain scores on injection were evaluated.

Statistical comparisons of age, weight, and height were analyzed by 1-way analysis of variance, and pain scores were made by Kruskal-Wallis test, followed by Mann-Whitney U test with Bonferroni correction for multicomparison. $P < .05$ was considered significant. Data are presented as mean ± SD (range) or median (range).

Clinical Comparison of Water-Diluted 0.25% and 0.2% Lidocaine

Outpatients complaining of various chronic myofascial pains to the same degree in both sides of the necks, shoulders, or lumbar regions, and willing to undergo trigger-point injections were consecutively enrolled into the study. Patients with pain apparently caused by organic musculoskeletal disabilities were excluded. Water-diluted 0.25% and 0.2% lidocaine were prepared using 1% lidocaine. After disinfecting the skin with an alcohol swab, 2 mL of either solution was injected intramuscularly into the most painful trigger-point on 1 side of the patient using a 25-gauge needle in a randomized, double-blind manner. A total of 2 mL of the other solution was injected into the most painful trigger-point on the other side of the patient in the same way. We prescribed no further treatment and medication and requested that patients should return to the clinic when the pain recurred. In this study, the patients were asked to grade the analgesic effect when analgesia was greatest as: almost complete pain relief = 1; good relief = 2; slight relief = 3; no change = 4; and aggravation of pain = 5, and to record the effective duration until the pain recurred.

Comparisons of the analgesic score and effective duration between 0.25% and 0.2% water-diluted lidocaine were analyzed by the Mann-Whitney U test and unpaired t test, respectively. $P < .05$ was considered significant. Data are presented as mean ± SD (range) or median (range).

Results

Evaluation of Types of Local Anesthetic and Water-Diluted Concentrations

The volunteers receiving water-diluted 0.25% lidocaine, saline-diluted 0.25% lidocaine, water-diluted 0.25% mepivacaine and water-diluted 0.0625% bupivacaine were statistically similar in age (28 ± 7 [20 to 38], 28 ± 7 [18 to 40], 28 ± 7 [20 to 40], 28 ± 7 [18 to 38] years), weight (53 ± 7 [47 to 67], 53 ± 6 [45 to 65], 53 ± 6 [47 to 65], 53 ± 7 [45 to 67] kg), and height (159 ± 8 [151 to 170], 157 ± 6 [149 to 169], 158 ± 7 [149 to 170], 159 ± 7 [151 to 170] cm). There was a significant difference in pain scores on injection between the groups ($P = .0013$, Kruskal-Wallis test). Lower pain scores were given after injection of water-diluted 0.25% lidocaine (1 [1 to 2]) and water-diluted 0.25% mepivacaine (1 [1 to 2]) than after saline-diluted 0.25% lidocaine (2.5 [1 to 4]) and water-diluted 0.0625% bupivacaine (2 [1 to 3]) (Table 1).

The volunteers receiving water-diluted 0.3%, 0.25%, 0.2%, and 0.15% lidocaine were similar in age (32 ± 8 [21 to 46], 31 ± 9 [19 to 47], 32 ± 8 [21 to 47], 31 ± 8 [19 to 46] years), weight (50 ± 6 [40 to 60], 50 ± 5 [42 to 58], 51 ± 6 [40 to 60], 50 ± 5 [42 to 57] kg), and height (156 ± 6 [151 to 168], 156 ± 4 [152 to 166], 156 ± 5 [152 to 168], 156 ±

Table 1. Pain Score on Injection of Local Anesthetics and Different Solvents

	Pain Score on Injection				
	1	2	3	4	
Water-diluted 0.25% lidocaine	9	1	0	0	*
Saline-diluted 0.25% lidocaine	3	2	3	2	*
Water-diluted 0.25% mepivacaine	9	1	0	0	*
Water-diluted 0.0625% bupivacaine	3	6	1	0	*

NOTE. Values are number of patients. Pain scores are: 1 = no pain, 2 = mild pain, 3 = moderate pain and 4 = severe pain.
*$P < .05$.

5 [151 to 166] cm). There was a difference in pain scores on injection between the groups ($P = .0001$, Kruskal-Wallis test). Lower pain scores were given after injection of water-diluted 0.25% (1 [1 to 2]) and 0.2% (1 [1 to 2]) lidocaine than after 0.3% (2 [1 to 2]) and 0.15% (2 [1 to 3]) (Table 2).

Clinical Comparison of Water-Diluted 0.25% and 0.2% Lidocaine

Of 27 outpatients enrolled into the study, 21 patients returned to the pain clinic and could be examined. Seven patients were men and 14 were women. Three patients suffered from chronic neck pain after whiplash injury, 10 patients suffered from chronic shoulder pain or stiffness, and 8 patients suffered from chronic lumbar pain. The age, weight, and height were 54 ± 18 (20 to 79) years, 58 ± 15 (43 to 100) kg and 156 ± 8 (143 to 174) cm, respectively. The water-diluted 0.25% lidocaine was applied to the trigger-point on the left side in 10 patients and on the right side in 11 patients, and water-diluted 0.2% lidocaine was applied similarly to the opposite sites. There was no difference in the analgesic score between 0.25% (1 [1 to 3]) and 0.2% (1 [1 to 3]) water-diluted lidocaine (Table 3). Regarding the effective duration, 0.25% and 0.2% water-diluted lidocaine resulted in effective analgesia for 20 ± 17 (2 to 60) and 20 ± 17 (2 to 60) days, respectively, again showing no difference.

Discussion

Because the principal aim of this study was to determine the treatment that caused the least pain on injection, the first study was designed to elucidate the type of local anesthetic and diluent that resulted in minimal injection pain. The results showed that water-diluted 0.25% lidocaine or 0.25% mepivacaine both resulted in less injection pain, while saline-diluted 0.25% lidocaine and water-diluted 0.0625% bupivacaine resulted in more pain. The latter solutions were therefore withdrawn from the study. Additional study revealed that the 0.2% to 0.25% lidocaine diluted in water caused less injection pain than the 0.3% and 0.15%, and the latter water-diluted concentrations were also withdrawn from the study. Our previous study,[10] using water-diluted 0.25% lidocaine, demonstrated less injection pain than the undiluted lidocaine, and lidocaine and mepivacaine have almost the same pharmacologic characteristics and clinical usage.[11] Considering these facts, we considered that the most suitable local anesthetic was lidocaine or mepivacaine, and the most effective concentration in water was 0.2% to 0.25% to result in the least injection pain.

Although water-diluted 0.2% to 0.25% lidocaine both caused minimal injection pain, any difference between the effective duration and analgesic impact delivered by these concentrations had not been examined. The follow-on study, using outpatients with various chronic myofascial pains, was designed to compare these factors. The results showed that both 0.2% and 0.25% water-diluted lidocaine had the same effects, and the mean effective duration was approximately 3 weeks and the majority of patients expressed almost complete pain relief. Our previous study[10] also demonstrated greater and longer effectiveness than the undiluted lidocaine. Thus, it is possible that our solution is more effective for treating chronic myofascial pain syndromes than the undiluted local anesthetic. From the present studies, consequently, we conclude that the suitable type of local anesthetic is lidocaine or mepivacaine, and the reasonable concentration in water is 0.2% to 0.25%.

The mechanism of water-diluted lidocaine or mepivacaine resulting in the least injection pain is unknown. Lidocaine or mepivacaine solutions are slightly acidic. Water dilution in a 1:3 or 1:4 ratio can not significantly change the pH levels, which

Table 2. Pain Score on Injection of Various Concentrations of Water-Diluted Lidocaine

	Pain Score on Injection				
	1	2	3	4	
Water-diluted 0.3% lidocaine	3	6	0	0	*
Water-diluted 0.25% lidocaine	9	1	0	0	† *
Water-diluted 0.2% lidocaine	9	1	0	0	†
Water-diluted 0.15% lidocaine	1	6	3	0	†

NOTE. Values are number of patients. Pain scores are: 1 = no pain, 2 = mild pain, 3 = moderate pain and 4 = severe pain.
*$P < .05$.
†$P < .01$.

Table 3. Comparison of the Analgesic Effects of Water-Diluted 0.25 and 0.2% Lidocaine

	Analgesic Score				
	1	2	3	4	5
Water-diluted 0.25% lidocaine	11	6	4	0	0
Water-diluted 0.2% lidocaine	12	6	3	0	0

NOTE. Values are number of patients. Analgesic scores are: 1 = almost complete pain relief, 2 = good relief, 3 = slight relief, 4 = no change, and 5 = aggravation.

was also shown by our examination (unpresented data). Injection of water alone causes a transiently intense burning pain sensation followed by analgesia.[6-9]

The present results revealed that saline-diluted 0.25% lidocaine has more injection pain than that diluted with water. Saline dilution theoretically results in almost no change of the pH level and osmotic pressure, and injection of saline causes comparable pain with local anesthetic, based on our experience. This suggests that the pain in saline-diluted 0.25% lidocaine has the same degree with that in undiluted lidocaine. Water-diluted 0.0625% bupivacaine had less effect on the pain of water injection, compared with lidocaine or mepivacaine. Bupivacaine has a greater dissociation constant (pKa) value and a smaller concentration of its base forms, resulting in delayed onset time of analgesia.[11] Thus, bupivacaine is not suitable as a preferred solution, because our aim was to determine the lowest concentration of local anesthetic required to prevent the pain of injection with water. Water-diluted 0.3% and 0.15% lidocaine also had less effect on the pain of water injection. We speculate that the higher dose of lidocaine in the former and greater volume of water in the latter cause more pain, respectively. The essential mechanism of the pain relief of our solution may be attributed to the water itself, and the 0.2% to 0.25% lidocaine or mepivacaine minimizes the pain of injection with water.

In conclusion, the suitable type of local anesthetic is lidocaine or mepivacaine, and the reasonable water-diluted concentration is 0.2% to 0.25%. The mechanism of the analgesic effect of this mixture on chronic myofascial pain syndromes may be attributed in principle to water itself, while low concentrations of local anesthetic prevent the pain of injection with water.

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