Torato et al. Renal Replacement Therapy (2016) 2:6
DOI 10.1186/s41100-016-0022-6

Renal Replacement Therapy

RESEARCH Open Access

The add-on effect of the Mutsu-Senshi® skin cooling device for needle insertion pain in hemodialysis patients: a multicenter prospective study

Toshihiro Torato[1], Masao Iwagami[1], Hiroshi Kawaguchi[2], Toshiaki Suzuki[3], Noriyuki Yamamoto[3], Shigeki Matsuo[4], Chiduru Ishikawa[1], Daisuke Katagiri[1], Yoshifumi Hamasaki[1], Norio Hanafusa[1], Masaomi Nangaku[5], Tsutomu Sanaka[6] and Eisei Noiri[1,5*]

Abstract

Background: Needle insertion pain associated with maintenance hemodialysis (HD) causes considerable stress on HD patients with native arteriovenous fistula. Skin cooling has been suggested to modify pain sensitivity and reduce needle insertion pain. Recently, a skin cooling device, named Mutsu-Senshi®, has been developed to decrease local skin temperature to 21 °C smoothly and safely at the bedside. Therefore, we examined the effectiveness of Mutsu-Senshi® in 4 HD centers in Japan.

Methods: We recruited adult patients receiving maintenance HD. After 1 week of HD in a conventional way, Mutsu-Senshi® was additionally used before the start of every HD in the second week. The disinfected Mutsu-Senshi® was placed on the disinfected access site before needle insertion to decrease skin temperature to 21 °C in 1 min. At the end of the second week, patients were asked to score relative changes in needle insertion pain on a modified visual analog scale (VAS) on a tablet computer in private, from −100 indicating a marked increase in pain intensity with Mutsu-Senshi® to +100 indicating a marked reduction in pain intensity with Mutsu-Senshi®. Results were presented on scatter and box plots, with subgroup analyses according to age, sex, HD vintage, reasons for end-stage renal disease, needle insertion site, the use of a lidocaine patch, and the diameter of needles used. Finally, a multivariate logistic regression analysis was conducted to examine factors associated with the patients' preferences for Mutsu-Senshi®.

Results: Of the 98 study participants with a native arteriovenous fistula (mean age 60.5 [standard deviation 13.8], men 66 %), 63 (64 %) rated Mutsu-Senshi® more favorably with modified VAS scores of >0. The median score was +29 with an interquartile range from ±0 to +58. Subgroup analysis revealed that patients using dialysis needles with larger diameters (15–17 gauge) tended to favor Mutsu-Senshi® compared with those using needles with a smaller diameter (18 gauge). Needle diameter was also an independent factor associated with favoring Mutsu-Senshi®.

Conclusions: These multicenter prospective study data suggest that the majority of patients receiving maintenance HD favor the use of the Mutsu-Senshi® skin cooling device before needle insertion. A group of patients using needles with larger diameters may benefit more from Mutsu-Senshi®.

(Continued on next page)

* Correspondence: noiri-tky@umin.ac.jp
[1]Department of Hemodialysis and Apheresis, The University of Tokyo Hospital, Bunkyo-ku, Tokyo 113-8655, Japan
[5]Department of Nephrology and Endocrinology, The University of Tokyo Hospital, Tokyo, Japan
Full list of author information is available at the end of the article

(Continued from previous page)

Trial registration: UMIN000011802

Keywords: Hemodialysis, Needle insertion, Skin cooling, Pain, Arteriovenous fistula

Background

The number of patients receiving dialysis for end-stage renal disease (ESRD) has been increasing worldwide and projected to more than double by 2030 [1]. Japan has the second highest prevalence of dialysis for ESRD, next to Taiwan, and the second largest number of patients receiving dialysis, next to the USA [1]. The number of Japanese patients receiving maintenance hemodialysis (HD) was over 300,000 in 2012 [2]. Among different types of vascular access available for HD, the native arteriovenous fistula has been historically preferred in Japan, accounting for nearly 90 % [3].

Pain associated with the insertion of dialysis needles can cause considerable stress on HD patients [4]. In fact, pain during needle insertion is the most common patient complaint regarding hemodialysis access [5]. Several approaches have been developed to minimize needle insertion pain, including buttonhole cannulation technique [6, 7], lidocaine-containing local anesthetic cream/patches [8, 9], and lavender essential oil [10, 11]. However, their effects are variable and unpredictable.

Thermosensation and pain sensitivity are closely related. Studies have shown that skin temperatures over 43 °C and below 15 °C evoke a feeling of pain [12, 13]. However, within this range of 15 °C through 43 °C, lower skin temperatures were associated with longer latencies to pain sensation indicating decreased pain sensitivity [14, 15]. Considering these findings, Daimon et al. tried to control pain during needle insertion for HD by decreasing skin temperature to 20 °C with a cooling gel [16]. Skin cooling was found to reduce needle insertion pain significantly and as effectively as lidocaine patches. With no adverse skin reactions related to the procedure, the use of skin cooling was suggested to be more favorable for patients allergic to lidocaine patches.

A handy-sized device named Mutsu-Senshi® (Creative Medical Engineering Co, Ishikawa, Japan) has recently been developed to cool the skin (Fig. 1). In Japanese, "Mutsu" means "painless," while "Senshi" is a play on words meaning both "centesis" and "fighter (for pain)." Mutsu-Senshi® with a thermoelectric mechanism was shown to bring the skin temperature down to around 21 °C in 1 min, without causing significant changes in the diameter of dialysis vessels [17]. It is expected that Mutsu-Senshi® can be used in the clinical practice more smoothly and safely than the method of using cooling gel.

However, Mutsu-Senshi® has never been formally evaluated for its effectiveness in multicenter studies. It is unknown what proportion of patients on HD favor the use of this device in the real-world practice. Another question is if there is any particular group of patients who respond better to Mutsu-Senshi®. This would be useful information for our clinical practice, allowing us to recommend Mutsu-Senshi® for those who will benefit most from this device. Therefore, this multicenter prospective study was planned to assess the effectiveness of the Mutsu-Senshi® skin cooling device in 4 dialysis centers in Japan.

Methods

This study was registered with UMIN Clinical Trials Registry, number UMIN000011802 [18]. After uploading the study protocol, we modified it to simplify the process and encourage a smooth operation of the study in the real work environment. The points changed were as follows: (i) observational periods for each patient were shortened from 3 weeks (a normal week, a week using

Fig. 1 Presentation of the Mutsu-Senshi® skin cooling device

Mutsu-Senshi®, and another normal week) to 2 weeks (a normal week and a week using Mutsu-Senshi®); (ii) patients were asked to evaluate the effect of Mutsu-Senshi® only at the end of the second week, instead of after every HD session; (iii) the pain scale was changed from a commonly used absolute visual analog scale (VAS) for assessment of pain intensity using numbers (e.g. 0–10) to a modified VAS for assessment of relative changes in pain intensity with Mutsu-Senshi®, as explained later.

Informed consent was obtained from individual patients. The study was approved by the institutional review board of the University of Tokyo.

Study population

We conducted the study in 4 HD centers in Japan (Medical Plaza Shinozaki, Tokyo; Asagaya-Suzuki Clinic, Tokyo; Tokiwakai Group Tokiwa Hospital, Fukushima; Akita City Hospital, Akita; and University of Tokyo Hospital, Tokyo), during the period between January and August, 2014. We recruited patients age 20 to 90 years who were receiving maintenance HD. Exclusion criteria included patients who may overreact to cold stimulation, those with sensory disturbance in the limbs, those with visual disturbance or hearing impairments, those unable to communicate adequately with observers (e.g., dementia), those with needle insertion troubles over the last 3 HD treatments, and those whom responsible doctors consider as inappropriate participants.

Intervention

For the first week after entry into the study, patients received HD in a conventional way, including needle insertion by trained medical staff. For the second week, Mutsu-Senshi® was additionally used, without changing any other procedure conducted in the first week. Patients using lidocaine patches continued to use them in the second week.

First, both the patient skin and the skin contacting surface of the Mutsu-Senshi® were disinfected. After switching on Mutsu-Senshi® and waiting until the temperature of its skin contacting surface dropped to 21 °C and an indicator lamp was lit, the cooling device was put on the access site before dialysis needle insertion. Mutsu-Senshi® is designed to beep either when the skin temperature reaches 21 °C or after 1 min of contact with the skin; 1 min is considered sufficient to decrease the skin temperature to around 21 °C for most users [17]. Finally, dialysis needles were inserted in the same way as the first week.

Assessment

At the end of the second week, we asked each participant to assess the effect of Mutsu-Senshi®. A modified VAS was created for this purpose, scoring from −100 indicating a marked increase in pain intensity with Mutsu-Senshi® to +100 indicating a marked reduction in pain intensity with Mutsu-Senshi®. The score ±0 indicates that patients did not find any difference with or without Mutsu-Senshi®. The participants were instructed about the modified VAS score entry on a tablet computer. No medical staff observed the process of entry to reduce response bias. The results were transferred electronically to the Lifestyle Disease Coordinator Association in Japan, anonymized, and then sent to the authors for analysis in the end of the study. The Lifestyle Disease Coordinator Association is totally independent of the manufacturer of Mutsu-Senshi® as well as participating HD centers.

Statistical analysis

Descriptive statistics were gathered for all eligible patients. Age was shown as mean and standard deviation (SD), while HD vintage was expressed as median and interquartile range (IQR). Categorical variables were shown with number of patients and proportion. Distribution of modified VAS was presented using a scatter plot as well as a box plot with the scores of median, IQR, minimum, and maximum. Scores outside of 1.5 times IQR were regarded as outliers and thus excluded for the box plotting. Then, subgroup analysis was conducted to identify any particular patient group benefiting more from Mutsu-Senshi®. Patients were classified into 2

Table 1 Baseline characteristics of study participants

	Patients ($n = 98$)
Age (years, mean ± SD)	60.5 ± 13.8
Sex (men)	65 (66 %)
Hemodialysis vintage (years, median [IQR])	4 [2–9]
Reasons for ESRD	
Diabetes	46 (47 %)
Chronic glomerular nephritis	12 (12 %)
Nephrosclerosis	9 (9 %)
Polycystic kidney disease	5 (5 %)
Others	4 (4 %)
Unknown	22 (22 %)
Needle insertion site	
Forearm	91 (93 %)
Upper arm	7 (7 %)
Use of lidocaine patch (yes)	40 (41 %)
Diameter of dialysis needle (gauge)	
18	40 (41 %)
17	27 (28 %)
16	28 (29 %)
15	3 (3 %)

ESRD end-stage renal disease, *IQR* interquartile range, *SD* standard deviation

groups for the following factors: age (<65 or ≥65), sex, HD vintage (<5 or ≥5 years), reason for ESRD (non-diabetes or diabetes), needle insertion site (forearm or upper arm), the use of lidocaine patches, and diameter of dialysis needles (15–17 gauge or 18 gauge). The cut-off points for classification were determined such that the number of patients in each subgroup was relatively similar. Box plots were used for the individual subgroup, and then a Wilcoxon rank sum test was conducted to examine whether any predefined factor was associated with increased preference for Mutsu-Senshi®. Finally, a multivariate logistic analysis was conducted. The outcome was modified VAS score >0 (vs. score ≤0), while exposures were all the variables used for the aforementioned subgroup analysis. All data were analyzed using Stata 14 software (Stata Corp, TX, USA). A P value of <0.05 was considered statistically significant.

Results

Ninety-eight patients (mean age 60.5 [SD 13.8], men 66 %) participated in the study (Table 1). All patients had native arteriovenous fistulas. All of them completed pain assessment and reported no adverse effects associated with Mutsu-Senshi®. As shown in Fig. 2, modified VAS scores were scattered from −100 to +100, and the box plot demonstrated the median score of +29 and IQR from ±0 to +58. The proportion of patients scoring >0 (i.e., favoring Mutsu-Senshi®) was 64 % (63/98). In a subgroup analysis (Fig. 3), there was no clear difference in the preference for Mutsu-Senshi® between younger (<65) and older (≥65) patients, between men and women, between shorter (<5 years) and longer (≥5 years) HD vintages, between patients for whom diabetes was or was not a cause of ESRD, and between the forearm and upper arm for needle insertion. However, patients using lidocaine patches tended to favor Mutsu-Senshi® compared to those not using them ($P = 0.089$). Patients using 15–17-gauge needles demonstrated significantly stronger preference for Mutsu-Senshi® than those using 18-gauge needles ($P = 0.006$). In a multivariate logistic regression analysis (Table 2), needles with larger diameters (15–17 gauge vs. 18 gauge) were significantly associated with favoring Mutsu-Senshi® (adjusted odd ratio 5.69, 95 % confidence interval [CI] 2.17–14.96). The patients were further divided into 3 groups by needle diameter (3 patients using 15 gauge were grouped into those using 16 gauge): 15–16 gauge ($n = 31$), 17 gauge ($n = 27$), and 18 gauge ($n = 40$) in a multivariate regression model. Compared with patients using 18-gauge needles, the adjusted odds ratio in favor of Mutsu-Senshi®

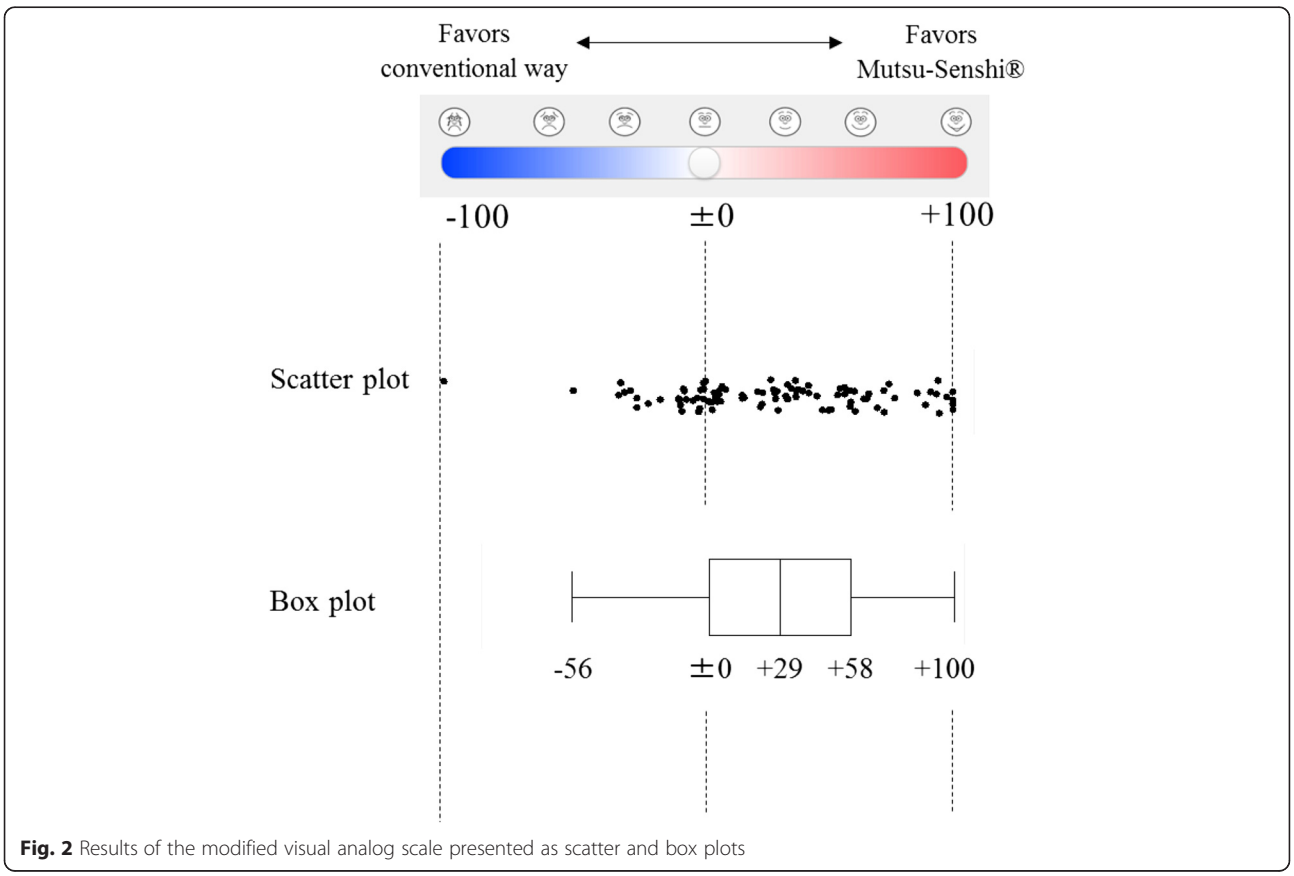

Fig. 2 Results of the modified visual analog scale presented as scatter and box plots

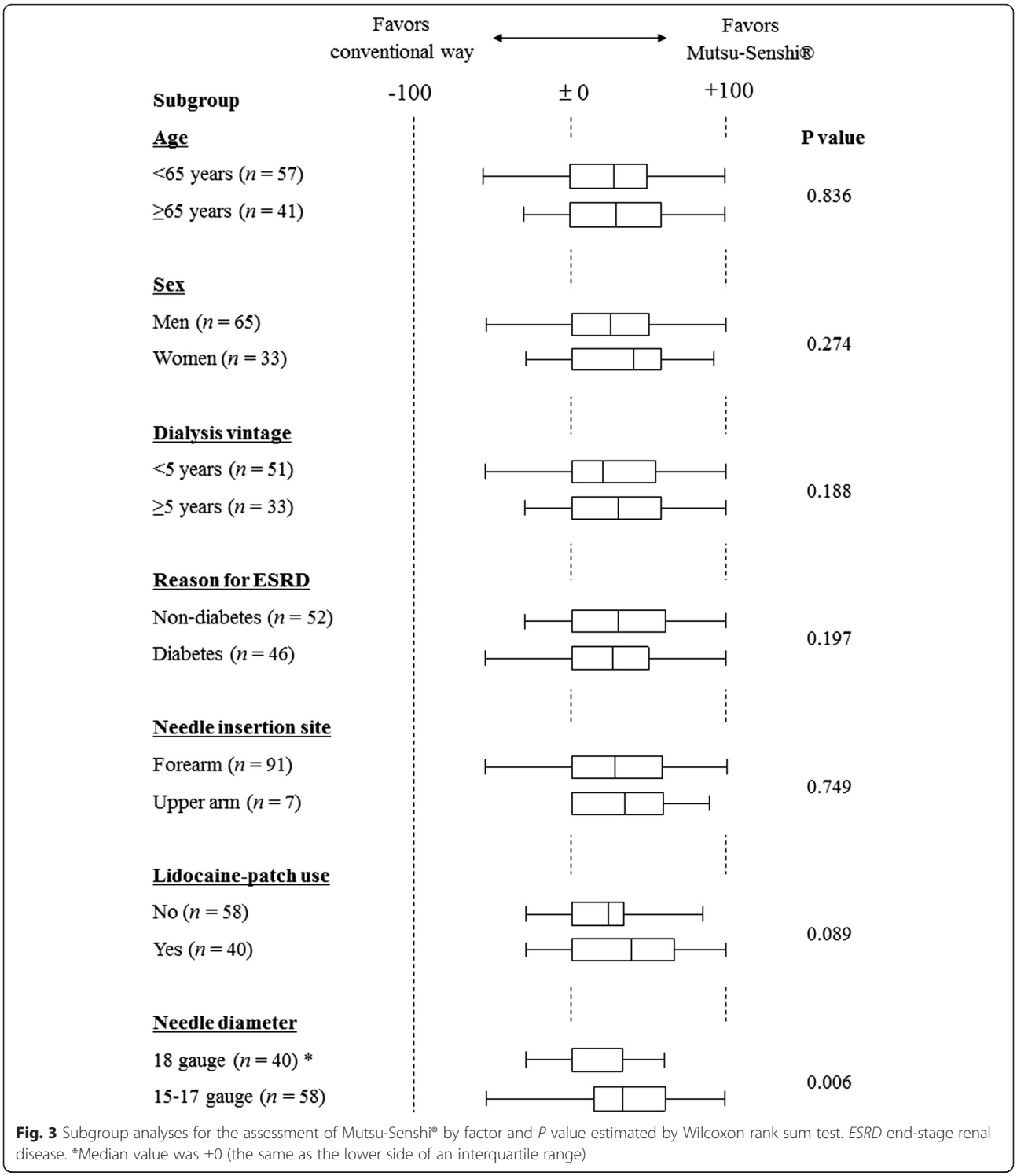

Fig. 3 Subgroup analyses for the assessment of Mutsu-Senshi® by factor and *P* value estimated by Wilcoxon rank sum test. *ESRD* end-stage renal disease. *Median value was ±0 (the same as the lower side of an interquartile range)

was 4.96 (95 % CI, 1.38–17.76) for those using 17-gauge needles and 6.25 (95 % CI, 2.01–19.41) for those using 15- or 16-gauge needles. These findings mean that, although there was a significant difference between 15–17-gauge and 18-gauge needles, no significant difference was observed between 15–16-gauge and 17-gauge needles.

Discussion

In this first prospective multicenter study, the Mutsu-Senshi® skin cooling device was suggested to be effective in reducing needle insertion pain in patients receiving HD. Mutsu-Senshi® was safely used in all of the 98 patients without any complications, and 63

Table 2 Multivariate logistic regression analyses for favoring Mutsu-Senshi® (modified visual analog scale >0)

	Adjusted odds ratio	95 % CI	*P* value
Age			
<65 years	Reference		
≥65 years	1.20	0.47–3.07	0.705
Sex			
Men	Reference		
Women	0.76	0.25–2.35	0.634
Dialysis vintage			
<5 years	Reference		
≥5 years	1.27	0.49–3.27	0.624
Reason for ESRD			
Non-diabetes	Reference		
Diabetes	0.63	0.23–1.75	0.375
Needle insertion site			
Forearm	Reference		
Upper arm	0.70	0.13-3.76	0.674
Lidocaine patch use			
No	Reference		
Yes	1.12	0.42-2.98	0.815
Needle diameter			
18 gauge	Reference		
15–17 gauge	5.69	2.17–14.96	<0.001

CI confidence interval, *ESRD* end-stage renal disease

(64 %) preferred Mutsu-Senshi® to conventional needle insertion without skin cooling. We also found that those using needles with larger diameter tended to rate Mutsu-Senshi® more favorably, and this factor was significant even in the multivariate regression analysis.

Needle insertion pain is a considerable stress for patients receiving HD [4, 5]. It may be associated with depressive symptoms and lower quality of life in patients with HD [19]. Therefore, various methods have been attempted to reduce needle insertion pain [6–11]. The buttonhole technique has been expected to decrease pain more effectively than the rope-ladder or rotating-site cannulation technique [6], but a recent meta-analysis concluded that no difference in cannulation pain was found between the 2 techniques in randomized controlled trials [7]. In contrast, lidocaine patches have been shown to be effective in reducing pain [8, 9] and were actually a popular pain management modality used by 40 of the 98 patients in our study population. However, lidocaine patches frequently cause skin problems such as pruritus and eczema. A Japanese study reported that among 26 HD patients using lidocaine patches, 15 complained of skin problems [20]. In our study, none of the participants reported skin problems associated with the use of Mutsu-Senshi®. This is probably because the extent of skin cooling with Mutsu-Senshi® was mild, only to 21 °C.

Sixty-four percent (63/98) of patients rated Mutsu-Senshi® more favorably for pain relief, although the median value of the modified VAS was not very large at +29 (IQR from ±0 to +58). A univariate analysis suggested that a subgroup of patients using lidocaine patches tended to favor Mutsu-Senshi®. We speculate that patients using lidocaine patches may be more sensitive to pain, or more particular about pain control methods, and therefore evaluated Mutsu-Senshi® more favorably than those not using lidocaine patches. Our findings also suggest that Mutsu-Senshi® can be used in combination with lidocaine patches in the real-world practice. In both univariate and multivariate analyses, larger needle diameters were associated with a higher preference for Mutsu-Senshi®. A potential explanation would be that patients using needles with larger diameters (15–17 gauge) might have had stronger needle fear. Therefore, the use of Mutsu-Senshi® might have provided them with greater relief than those using smaller diameter (18 gauge) needles. However, no difference was observed between 15–16-gauge and 17-gauge needles, which may be explained by the small sample size or influence of confounding factors. Further study may be necessary to examine the association between needle diameter and the usefulness of Mutsu-Senshi®.

This study has several strengths. First, patients were recruited from 4 HD centers, increasing the generalizability of the results. Second, all the prescribed conditions were kept unchanged between the first and second weeks, except for the additional use of Mutsu-Senshi®. In particular, patients using lidocaine patches were allowed to continue this use through the second week. Therefore, our findings on the usefulness of Mutsu-Senshi® can be quickly applied to the current bedside practice without any modification. Finally, the modified VAS was administered while the medical staff were not observing. Patients may respond to the questionnaire differently if they know they are being watched, probably leading to a more favorable assessment of the new treatment. By reducing response bias, we fairly examined the usefulness of Mutsu-Senshi®.

However, this study also has limitations. First, an ideal way of assessing the effect of Mutsu-Senshi® may be to ask patients about their pain at the end of every HD session, because pain severity can vary from day to day. Calculating and comparing the average absolute pain scores of several needle insertions with and without Mutsu-Senshi® could have achieved even fairer assessment of Mutsu-Senshi®. However, to recruit many patients and operate the study in the real-world clinical

environment with a limited number of medical staff, we had to change the protocol to a single assessment comparing needle insertion pain with and without Mutsu-Senshi® only 1 time at the end of the second week. For this purpose, we had to modify a commonly used absolute VAS to a comparative one, making it difficult to compare the effectiveness of Mutsu-Senshi® with other pain control modalities such as lidocaine patches [8, 9] and lavender essential oil [10, 11]. Second, our study population mostly included patients receiving HD for 1 year or longer. Therefore, the study participants might be more tolerant of needle insertion pain than those recently introduced to HD. It remains unknown whether Mutsu-Senshi® is beneficial for patients who have undergone HD for a shorter time period and who may be more sensitive to the pain. Finally, although the diameter of dialysis needles was suggested to be an independent factor for increased preference for Mutsu-Senshi®, this finding might be influenced by unmeasured confounding factors, such as skin thickness and mental health conditions. Further studies are warranted to examine the usefulness of Mutsu-Senshi® and to identify the most appropriate target population.

Conclusions

This multicenter prospective study suggested that the Mutsu-Senshi® skin cooling device may help HD patients with native arteriovenous fistula to better cope with needle insertion pain without causing skin complications. The majority (64 %) of HD patients favored the use of Mutsu-Senshi® before needle insertion. Patients using needles with larger diameters may benefit more from Mutsu-Senshi®.

Abbreviations

CI: confidence interval; ESRD: end-stage renal disease; HD: hemodialysis; IQR: interquartile range; SD: standard deviation; VAS: visual analog scale.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

EN and TS conceived of the study, participated in its design and coordination, and edited the manuscript. TT assisted the study operation and data collection, analyzed the data, and drafted the manuscript. MI and NH analyzed the data and drafted the manuscript. HK, TS, NY, and SM assisted the study operation and data collection. CI assisted the study operation and data collection. DK, YH, and MN conceived of the study and participated in its coordination. All authors read and approved the final manuscript.

Acknowledgements

This study was partly supported by Grant of Tokyo-Joto Renal Research Association approved by the Kidney Foundation, Japan.

Author details

[1]Department of Hemodialysis and Apheresis, The University of Tokyo Hospital, Bunkyo-ku, Tokyo 113-8655, Japan. [2]Kidney Center, Tokiwakai Group Tokiwa Hospital, Fukushima, Japan. [3]Asagaya-Suzuki Clinic, Tokyo, Japan. [4]Department of Urology, Akita City Hospital, Akita, Japan. [5]Department of Nephrology and Endocrinology, The University of Tokyo Hospital, Tokyo, Japan. [6]Medical Plaza Shinozaki, Tokyo, Japan.

Received: 20 October 2015 Accepted: 30 November 2015
Published online: 14 March 2016

References

1. Liyanage T, Ninomiya T, Jha V, Neal B, Patrice HM, Okpechi I, et al. Worldwide access to treatment for end-stage kidney disease: a systematic review. Lancet. 2015;385:1975–82.
2. Nakai S, Hanafusa N, Masakane I, Taniguchi M, Hamano T, Shoji T, et al. An overview of regular dialysis treatment in Japan (as of 31 December 2012). Ther Apher Dial. 2014;18:535–602.
3. Nakai S, Suzuki K, Masakane I, Wada A, Itami N, Ogata S, et al. Overview of regular dialysis treatment in Japan (as of 31 December 2008). Ther Apher Dial. 2010;14:505–40.
4. Dinwiddie LC, Ball L, Brouwer D, Doss-McQuitty S, Holland J. What nephrologists need to know about vascular access cannulation. Semin Dial. 2013;26:315–22.
5. Bay WH, Van Cleef S, Owens M. The hemodialysis access: preferences and concerns of patients, dialysis nurses and technicians, and physicians. Am J Nephrol. 1998;18:379–83.
6. Wong B, Muneer M, Wiebe N, Storie D, Shurraw S, Pannu N, et al. Buttonhole versus rope-ladder cannulation of arteriovenous fistulas for hemodialysis: a systematic review. Am J Kidney Dis. 2014;64:918–36.
7. van Loon MM, Goovaerts T, Kessels AG, van der Sande FM, Tordoir JH. Buttonhole needling of haemodialysis arteriovenous fistulae results in less complications and interventions compared to the rope-ladder technique. Nephrol Dial Transplant. 2010;25:225–30.
8. Çelik G, Özbek O, Yılmaz M, Duman I, Özbek S, Apiliogullari S. Vapocoolant spray vs lidocaine/prilocaine cream for reducing the pain of venipuncture in hemodialysis patients: a randomized, placebo-controlled, crossover study. Int J Med Sci. 2011;8:623–7.
9. Ooi K. Differences in pain anesthetic effect expression on using lidocaine tape for hemodialysis patients. Yakugaku Zasshi. 2007;127:1797–9.
10. Bagheri-Nesami M, Espahbodi F, Nikkhah A, Shorofi SA, Charati JY. The effects of lavender aromatherapy on pain following needle insertion into a fistula in hemodialysis patients. Complement Ther Clin Pract. 2014;20:1–4.
11. Ghods AA, Abforosh NH, Ghorbani R, Asgari MR. The effect of topical application of lavender essential oil on the intensity of pain caused by the insertion of dialysis needles in hemodialysis patients: a randomized clinical trial. Complement Ther Med. 2015;23:325–30.
12. LaMotte RH, Campbell JN. Comparison of responses of warm and nociceptive C-fiber afferents in monkey with human judgments of thermal pain. J Neurophysiol. 1978;41:509–28.
13. Tillman DB, Treede RD, Meyer RA, Campbell JN. Response of C fibre nociceptors in the anaesthetized monkey to heat stimuli: correlation with pain threshold in humans. J Physiol. 1995;485:767–74.
14. Pertovaara A, Kauppila T, Hämäläinen MM. Influence of skin temperature on heat pain threshold in humans. Exp Brain Res. 1996;107:497–503.
15. Berge OG, Garcia-Cabrera I, Hole K. Response latencies in the tail-flick test depend on tail skin temperature. Neurosci Lett. 1988;86:284–8.
16. Daimon S, Seto T, Hoshiba N, Takeichi M, Matsuyama M, Sawasaki M, et al. Effect of local cooling of the skin to control pain during arteriovenous fistula cannulation in hemodialysis patients. Nihon Toseki Igakkai Zasshi. 2010;43:429–32.
17. Asakawa Y, Asano K, Yamamoto N, Matsuzaki R, Miura A, Suzuki A, et al. Examination of needle insertion pain reduction by a skin cooling device. Tokyo Toseki Kondankai [Japanese]. http://www.tokyo-hd.org/pdf/42th/42th_02_008.pdf. Accessed at 1 Oct 2015.
18. UMIN CTR https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr.cgi?function=brows&action=brows&type=summary&recptno=R000013800&language=J. Accessed 1 Oct 2015.
19. Harris TJ, Nazir R, Khetpal P, Peterson RA, Chava P, Patel SS. Pain, sleep disturbance and survival in hemodialysis patients. Nephrol Dial Transplant. 2012;27:758–65.
20. Saikawa Y, Matsubara M, Kamiya C, Egawa T. Needle insertion pain variation through use of lidocaine tape following skin hydration in hemodialysis patients. Kansai Univ Nurs Health Sci. 2012;4:6–13.