THE JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE
Volume 20, Number 5, 2014, pp. 356–363

DOI: 10.1089/acm.2013.0319

Auricular Acupressure Helps Improve Sleep Quality for Severe Insomnia in Maintenance Hemodialysis Patients: A Pilot Study

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Abstract

Background: Insomnia is common in patients undergoing maintenance hemodialysis (MHD). Long-term use of sedative-hypnotic agents is often correlated with increasing adverse effects. Auricular acupressure therapy (AAT) applied to specific auricular acupoints for managing insomnia has achieved favorable outcomes in a hemodialysis unit. This pilot study was performed to demonstrate the potential of AAT for insomnia in MHD patients and to prepare for a future randomized controlled trial.

Methods: Eligible patients were enrolled into this descriptive pilot study and received AAT designed to manage insomnia for 4 weeks. Questionnaires that used the Pittsburgh sleep quality index (PSQI) were completed at baseline, after a 4-week intervention, and 1 month after completion of treatment. Sleep quality and other clinical characteristics, including sleeping pills taken, were statistically compared between different time points.

Results: A total of 22 patients were selected as eligible participants and completed the treatment and questionnaires. The mean global PSQI score was significantly decreased after AAT intervention ($p < 0.05$). Participants reported improved sleep quality ($p < 0.01$), shorter sleep latency ($p < 0.05$), less sleep disturbance ($p < 0.01$), and less daytime dysfunction ($p = 0.01$). They also exhibited less dependency on sleep medications, indicated by the reduction in weekly estazolam consumption from 6.98 ± 4.44 pills to 4.23 ± 2.66 pills ($p < 0.01$). However, these improvements were not preserved 1 month after treatment.

Conclusion: In this single-center pilot study, complementary AAT for MHD patients with severe insomnia was feasible and well tolerated and showed encouraging results for sleep quality.

Introduction

Insomnia is one of the most common sleep problems of patients with chronic kidney disease, especially those undergoing long-term hemodialysis.[1–3] It was reported that about 45%–84.5% of dialysis patients experienced sleep disorders, and this problem was associated with decreased health-related quality of life.[1–5] Data from the Dialysis Outcomes and Practice Patterns Study showed that nearly half (49%) of dialysis patients reported poor sleep quality and that poorer sleep quality was associated with significantly lower mental and physical component summary scores and higher mortality.[6]

Despite recent advances in medicine in managing insomnia, patients experience a variety of problems, including adverse effects from and dependency on drugs.[7,8] For those undergoing dialysis, the desired effects are seemingly attained only at high doses, which increases the risks of adverse effects, such as memory problems, drug resistance, dependency, and addiction.[9] Many individuals continue to report significant sleep disturbances despite appropriate use of hypnotic medications. Apart from pharmacologic management, complementary and alternative medicine provides other approaches, such as relaxation therapy, cognitive-behavioral therapy, herbal medicines, acupuncture, and auricular acupressure.[10]

Auricular acupressure is a therapeutic method in which specific ear points are stimulated to treat various disorders. This practice is based on the theory that specific points on the auricles correspond to major organs or systems of the body, and therapeutic effects on the corresponding target organ or system can be achieved by manipulating auricular acupoints.

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Auricular acupressure applies stimulation through pressure by embedded beads, usually *Semen vaccariae* seeds (*wang bu liu xing*) or stainless steel beads. Compared with needle acupuncture, this therapeutic method is noninvasive and can be self-administered by recipients at the appropriate time.

Although auricular acupressure therapy (AAT) is commonly applied, its potential role for insomnia in MHD patients has not been fully studied. In a systematic review by Yeung and colleagues,[11] most of the clinical trials for auricular acupressure were conducted in the general population. As an exception, Zhang's study[12] examined the efficacy of AAT on MHD patients with insomnia and found that Pittsburgh sleep quality index (PSQI) scores of patients receiving AAT for 4 weeks were significantly decreased compared with those of the control group. Another study focusing on Korean hemodialysis patients found that AAT improved sleep satisfaction scores.[13] The investigators of these trials in hemodialysis patients did not adopt international criteria to diagnose insomnia or to evaluate the treatment. All these limitations prevent the ability to draw firm conclusion regarding the efficacy of AAT in the MHD population.[11,14] In particular, no clinical trial has addressed a dialysis population experiencing severe insomnia. In view of this, the current observational study on the efficacy of auricular acupressure on MHD patients with insomnia was conducted to lay the foundation for a planned registered randomized controlled trial (Chinese Clinical Trial Registry ChiCTR-TRC-12002272).

Materials and Methods

Study design

The present study was a descriptive observational pilot study. Participants were MHD patients selected from Guangdong Provincial Hospital of Chinese Medicine. Eligible patients were enrolled and treated with AAT to manage their insomnia. Questionnaires that used the PSQI were completed at baseline and after a 4-week intervention. Patients were informed of potential benefits and adverse effects of AAT. Although adverse events of auricular acupressure were rarely reported, any discomfort of the ear and allergic reaction were addressed by reference to those of acupuncture.[15] Written consent to participate in the trial was obtained before enrollment. The hospital's institutional review board approved this study.

Inclusion criteria

Participants were MHD patients from the local hemodialysis center who underwent dialysis two to three times a week (total treatment ≥ 10 hours per week). Those meeting all of the following criteria were included: duration of dialysis >3 months; age 18–75 years; insomnia diagnosed according to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision*;[16] global PSQI score >7; and provision of informed consent.

Exclusion criteria

Patients with any of the following conditions were excluded: presence of concurrent conditions (e.g., cancer, congestive heart failure, connective tissue disease, hematologic diseases) and psychiatric disorders; inadequate dialysis, indicated by urea clearance index (KT/V) <1.20; presence of severe physical symptoms, such as bone pain and itchy skin, that are obvious causes of insomnia; fatigue caused by severe anemia (hemoglobin <60 g/L); or malnutrition (serum albumin <30 g/L).

Treatment protocol and period

Participants in the treatment group received AAT on five specific acupoints: *shen men* (TF4), sympathetic autonomic (AH6a), heart (CO15), subcortex (AT4), and endocrine (CO18), as indicated in Figure 1. The treatment duration was 4 consecutive weeks. Other treatments, including

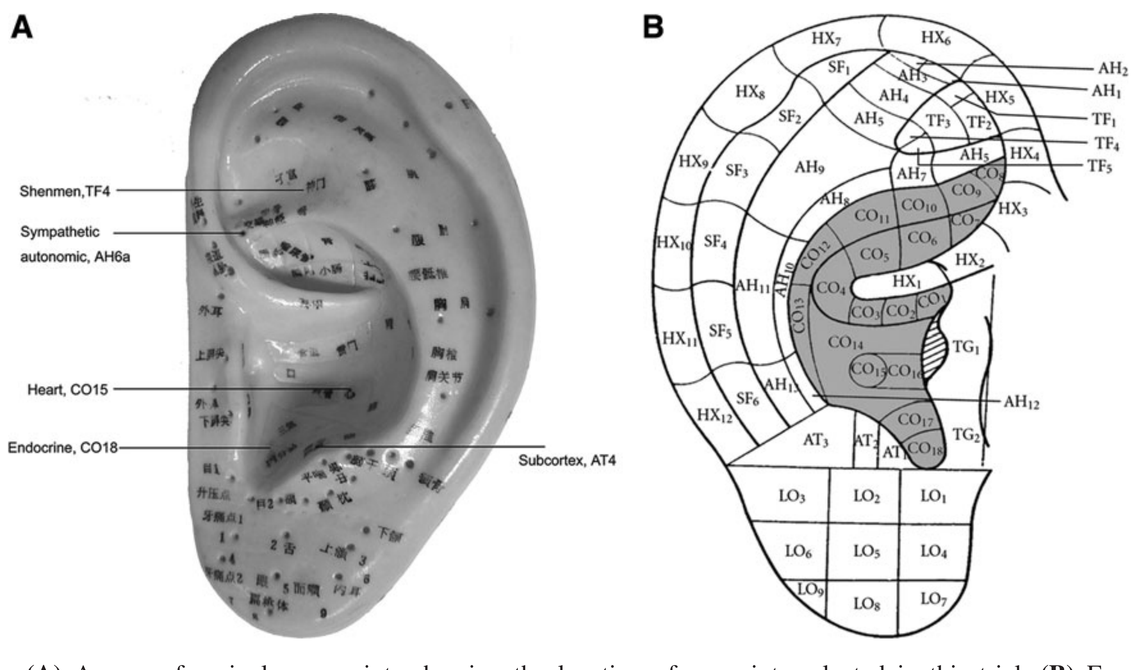

FIG. 1. **(A)** A map of auricular acupoints showing the location of acupoints selected in this trial. **(B)** Ear chart of auricular partition.

dialysis and pharmaceutic treatment of hypertension, anemia, were continued.

Rationale for acupoint selection

Auricular acupoints are selected on the basis of Traditional Chinese Medicine (TCM) meridian theory, results of literature review, and onsite clinical practice experience.

According to ancient TCM theory, sleep problems are mainly due to dysfunction of the heart.[17] The acupoints selected are closely related to this basic consensus. *Shen men* is related to the heart and is able to calm the spirit. Stimulation of *shen men* relaxes patients. The heart acupoint has mostly the same function as *shen men* but directly relates to the heart organ. The other acupoints help with self-modulation of internal organs. Anatomically, these points are mainly located at the triangular fossa and cavum conchae of the ear, where the auriculotemporal nerve and the auricular branch of the vagus nerve distribute. These nerves play an important role in regulation of the autonomic nervous system.[18,19] In addition, the role of the autonomic nervous system in insomnia has long been recognized.[20] Several investigations[21–23] have shown that stimulation at the *shen men* or heart points or a combination with some other points regulated vagal activity by increasing parasympathetic activities and reducing sympathetic activities.

For the current study, onsite TCM clinics were further investigated; the treatment protocol for sleep disorder mostly preferred by acupuncture practitioners involved the above acupoints. These acupoints were also found to be the most frequently used by TCM practitioners in the literature review. As mentioned in a systematic review by Cao and colleagues,[24] the top five auricular acupoints for insomnia treatment were *shen men* (TF4), *pi zhi xia* (AT4), *jiao gan* (AH6a), heart (CO15), and liver (CO12), in sequence. On the basis of the above information, an acupressure treatment protocol was developed in consensus with the authors' acupuncture peers, which included *shen men* (TF4), *pi zhi xia* (AT4), *jiao gan* (AH6a), heart (CO15), and endocrine (CO18).

Standard procedure for AAT manipulation

AAT was performed when patients were receiving hemodialysis in a relaxed position. Each point was sterilized with 75% isopropyl alcohol before an adhesive plaster (1.0 cm × 1.0 cm) was attached with one bead (*S. vaccariae*, globes of approximately 2.0 mm in diameter; surface: smooth; color: black [Taicheng Technology & Development Co., LTD, Shanghai, China]) embedded. Patients were instructed to press the beads with appropriate strength until a slight soreness was felt on the points, for around 5 minutes each time. This was performed three times during the day and 1 hour before sleep. Both ears were used alternately to avoid skin lesion caused by longtime adhesion. If the plaster detached at any time during the study, it was replaced without delay. To avoid inconvenience of making wasted journeys, the attachments were usually replaced on the patient's dialysis day. Therefore, replacement occurred every 2–3 days.

Auricular acupoint identification

According to the national standards of the nomenclature and location of auricular acupoints published in China,[25] the location of ear points was described as follows (see Fig. 1A and B):

- *Shen men* (TF4): at the apex of the triangular fossa, in the bifurcating point between superior and inferior crura of antihelix
- *Jiao gan* (AH6a): at the end of inferior antihelix crus.
- Heart (CO15): around the central depression of the cavum conchae
- Subcortex (AT4): at the medial side of antitragus
- Endocrine (CO18): in the intertragic notch, at the medial inferior part of the cavum concha

An ear model with a map of acupoints was provided to help the research nurses identify points as accurately as possible. The patients were expected to have a tender sensation when the acupoints were probed.

Practitioner background

All practitioners applying AAT in this trial were research nurses who had completed a training course provided by licensed acupuncturists. They were also well trained regarding the trial's procedure and had their competency assessed by senior acupuncturists before participating in the study.

Outcome measurements

Patient sleep quality was measured by PSQI scoring[26] (permission to use PSQI was granted from Professor Buysse by email). Liu and colleagues tested the reliability and validity of the Chinese version of the PSQI score and considered it suitable for Chinese population.[27] Sleep quality was evaluated at baseline and after a 4-week intervention. Clinical and laboratory data, including sleep medication use, were also assessed before and after the intervention. One month after completion of treatment, sleep quality was re-evaluated. All data were collected and managed by one of the team members who was not involved in the treatment.

Statistical analysis

Results of the study are given as mean ± standard deviation (SD) or frequencies and percentages when appropriate. Comparisons were conducted between different time points. For normally distributed variables, means were compared by using paired *t*-tests (two-tailed), and nonparametric variables were analyzed using Pearson χ^2 tests or Fisher exact tests. P values < 0.05 were considered to represent statistically significant differences. Statistical analyses were performed with SPSS software, version 13 (SPSS Inc., Chicago, IL). On the basis of the changes in PSQI scores observed in this study, a statistical power calculation was performed. Sample size calculation was based on difference in total PSQI score change between intervention and control group using a medium effect size.

Results

Twenty-two patients were enrolled as eligible participants. The mean patient age was 57.18 ± 9.86 years. All patients were married. Most were female (63.6%) and were not working (90.9%) at the time of the study. The duration of dialysis ranged from 4 to 216 months (median duration, 48.5 months). The duration of sleep disorders ranged from 0.5 to 15 years (median duration, 4.09 years). The primary diseases causing uremia were chronic glomerular disease, diabetes, hypertension, and obstructive nephropathy. Most of the participants were receiving dialysis treatment during the daytime, except two who were primarily treated at night. Patients were advised to avoid potential drinks known to affect sleep, such as tea and coffee. None of them smoked. Table 1 shows more details on the patients' demographic characteristics and their clinical status.

The patients enrolled had good nutritional status and were well dialyzed. However, many had severe hyperparathyroidism due to limited medicine and diet control. These confounding factors did not essentially change, by medicine or AAT, during the trial. The data showed that in the observational period, hemoglobin, serum albumin, serum calcium, phosphate, and intact parathyroid hormone levels did not significantly change (Table 2).

Table 3 shows the PSQI results before and after the intervention. The mean global PSQI score was significantly decreased after AAT intervention ($p<0.01$). Participants reported improved sleep quality ($p<0.01$), shorter sleep latency ($p<0.01$), and less sleep disturbance ($p<0.05$) and daytime dysfunction ($p<0.01$). The total PSQI score was decreased by 3.32 ± 3.44 on average. Patients were also less dependent on sleep medications (Table 4). Patients were encouraged to reduce the dose of sleep medications or the drug frequency when they were satisfied with sleep quality improvement. After AAT, fewer patients were taking more than two estazolam pills daily ($p<0.05$), and fewer patients were taking sleeping pills every night ($p=0.163$). The average weekly dose of estazolam decreased from 6.98 ± 4.44 pills to 4.23 ± 2.66 pills ($p<0.01$). With AAT, more than half (63.6%) of the included patients successfully reduced their usual sleeping pill dosage, either by reducing the single dose or by trying to omit their estazolam on some nights.

Table 1. Baseline Participant Characteristics

Characteristic	Value
Age (yr)	57.18 ± 9.86
Sex, *n* (%)	
Female	14 (63.6)
Male	8 (36.4)
Marriage, *n* (%)	22 (100)
Employment status, *n* (%)	
Working	2 (9.1)
Not working	20 (90.9)
Education, *n* (%)	
Elementary school	18 (81.8)
High school	4 (18.2)
Primary renal disease, *n* (%)	
Diabetes	5 (22.7)
Hypertension	3 (13.6)
Chronic glomerular disease	9 (40.9)
Obstructive nephropathy	3 (13.6)
Other	2 (9.1)
Duration on dialysis (mo)[a]	48.5 (25, 76.3)
Duration of sleep disturbance (mo)[a]	4.09 (2, 4.9)
Dialysis shift, *n* (%)	
Morning	9 (40.9)
Afternoon	11 (50)
Night	2 (9.1)
Ultrafiltration (L)	2.64 ± 0.68
Hemoglobin (g/dL)	11.6 ± 3.5
Albumin (g/dL)	3.97 ± 0.30
Calcium (mmol/L)	2.38 ± 0.59
Phosphorus (mmol/L)	2.14 ± 0.71
Parathyroid hormone (pg/mL)	995.3 ± 651.64
Kt/V	1.55 ± 0.23

Values expressed with a plus/minus sign are the mean ± standard deviation.
[a]Median quartiles.
Kt/V, urea clearance index.

Table 2. Laboratory Values Before and After Intervention

Variable	*Pre-AAT*	*Post-AAT*	p-*Value*
Hemoglobin (g/dL)	11.6 ± 3.5	11.5 ± 3.3	0.930
Albumin (g/dL)	3.97 ± 0.30	3.99 ± 2.75	0.827
Calcium (mmol/L)	2.38 ± 0.59	2.36 ± 0.59	0.925
Phosphorus (mmol/L)	2.14 ± 0.71	2.15 ± 0.70	0.838
Intact parathyroid hormone (pg/mL)	995.3 ± 651.6	945.0 ± 600.6	0.801
Kt/V	1.55 ± 0.23	1.53 ± 0.25	0.836

Values expressed with a plus/minus sign are the mean ± standard deviation.
AAT, auricular acupressure therapy.

AAT led to a reduction in total sleep quality score by 3.32 ± 3.44, whereas a previous similar study reported that total sleep quality score changed in a group that received an information control intervention (similar to usual care) by 0.55 ± 0.44.[28] In other studies of hemodialysis patients, control intervention led to a change in total PSQI score that, on average, ranged from -0.16 to 2.[29–31] In the current study, the placebo effect on total PSQI score was assumed to be -1 at most. Therefore, the effect size by Cohen's d was 0.97 (95% confidence interval, -0.47 to 1.15). Therefore, expecting differences at post-treatment between AAT for insomnia and usual care as control group, and by using a medium effect size of 0.6 with power of 80% ($p=0.05$) and 15% attrition, a minimum of 106 participants (53 in each group) would be needed. Our planned randomized controlled trial would be performed using these data of sample size estimation.

One month after completion of treatment, the results showed that sleep quality had worsened, with almost all component scores returning to baseline levels ($p>0.05$), except for sleep disturbance (1.36 ± 0.58 versus 1.00 ± 0.00; $p<0.01$). The average weekly consumption of estazolam increased to 6.53 ± 4.16 pills.

Overall, the results showed that patients' sleep quality improved and they were less dependent on medications after 1 month of AAT. However, these improvements were not maintained 1 month after the treatment ended (Figs. 2 and 3). The safety of this treatment was satisfactory; no adverse events occurred during the trial.

Discussion

Insomnia is highly prevalent in the hemodialysis population. Diverse approaches other than hypnotics are used as

Table 3. Pittsburgh Sleep Quality Index Scores Before and After Intervention

PSQI component	*Before intervention*	*After intervention*	p-*Value*
Sleep quality	2.14 ± 0.56	1.50 ± 0.51	0.000
Sleep latency	2.59 ± 0.73	2.14 ± 1.04	0.021
Sleep duration	2.09 ± 0.97	1.59 ± 0.85	0.061
Habitual sleep efficiency	1.91 ± 1.19	1.68 ± 1.21	0.479
Sleep disturbance	1.36 ± 0.58	1.00 ± 0.00	0.008
Sleep medication	2.55 ± 0.74	2.05 ± 1.21	0.018
Daytime dysfunction	1.86 ± 1.08	1.23 ± 0.81	0.010
Global PSQI score	14.5 ± 3.49	11.18 ± 3.58	0.000

Values expressed with a plus/minus sign are the mean ± standard deviation.
PSQI, Pittsburgh sleep quality index.

complements and alternatives. Auricular acupressure is one of the most commonly applied treatments in China; as a result, scientific investigations on its effect, safety, and mechanism are needed. The results of this pilot study demonstrate that a 4-week auricular acupressure regimen based on ear *shen men,* sympathetic autonomic, heart, subcortex, and endocrine improves sleep quality and reduces hypnotic use for MHD patients. These findings, partly consistent with those of previous studies,[12,13] suggest that AAT might be a useful therapeutic approach in managing sleep disturbances for hemodialysis patients, and may lead to discontinuing or minimizing sleep medication use for those with severe insomnia.

A previous study claimed that AAT had effects after treatment. In that study, only 30% of patients receiving AAT needed hypnotic aids, compared with 90% in the estazolam group and 55% in the usual care group at 6-month follow-up.[12] However, the current study found that the improvements diminished when the patients ceased AAT for 1 month. This phenomenon could be explained by the limited effectiveness of AAT or the severity of insomnia. On the other hand, it also underscores the contribution of AAT to the improvement in sleep quality.

Patient selection is a critical factor influencing effect evaluation. Apart from demographic characteristics, such as age, sex, dialysis duration and shift, complications or comorbid conditions could also affect insomnia severity and the expected effect of treatment. Hemoglobin, albumin, and parathyroid hormone levels were also found to be important factors.[32–36] These characteristics of patients in previous studies were not well described. All patients enrolled in the present study had severe hyperparathyroidism; their mean PSQI score at baseline was 14.5, and they were all receiving hypnotic medications. In this situation, it was assumed that AAT could improve sleep quality and reduce the dosage of estazolam, but it might not be sufficient to totally replace the pharmacologic sleep aids. Therefore, this study did not directly compare the effect of AAT with that of medicine, or of AAT with placebo; however, an add-on study was conducted. In Zhang's study,[12] both medicine (estazolam) and usual care were set as controls. It turned out that patients receiving AAT had better sleep quality than patients in the other two groups. Lee and Kim[13] compared AAT with usual care and also showed results favorable to AAT. The current study showed, by pre- and post-treatment comparisons, a trend of sleep quality improvement by AAT on MHD patients with severe insomnia.

Another concern about the results is that the influence of Hawthorne and Rosenthal effects might exist because acupoint names in Chinese often reflect some effect of the point (e.g., spirit gate, heart). Future studies might try to

Table 4. Sleep Medication Use Before and After Intervention

Variable	*Pre-AAT*	*Post-AAT*	p-*Value*
Dose (*n*)			
2 pills daily	6	0	0.032[a]
1.5 pills daily	1	1	
1 pill daily	14	18	
0.5 pill daily	1	3	
Frequency (*n*)			
Every night (7/week)	14	7	0.163[a]
3–6/week	2	6	
1–2/week	5	7	
< 1/week	1	2	
Averaged weekly dose (pills)	6.98 ± 4.44	4.23 ± 2.66	0.003

Values expressed with a plus/minus sign are the mean ± standard deviation.
[a]Fisher exact test, sleep medication: estazolam (1 mg/pill).

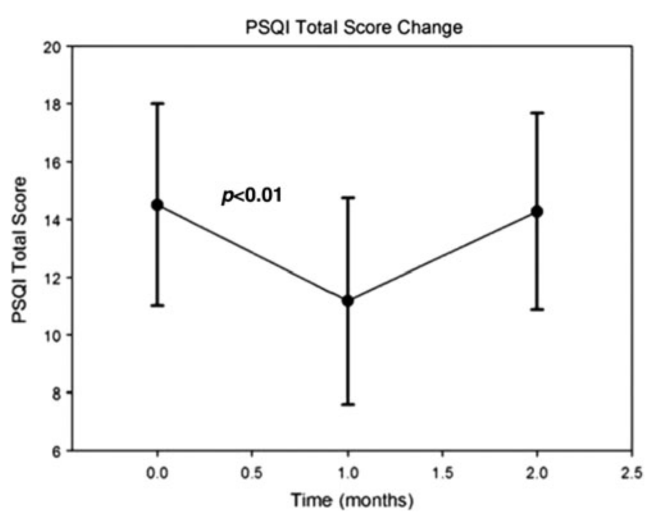

FIG. 2. Pittsburgh sleep quality index (PSQI) total scores (means ± standard error of the mean) at baseline, after 4-week treatment, and 1 month after treatment. Significant difference between baseline and after 4-week treatment is showed ($p < 0.01$).

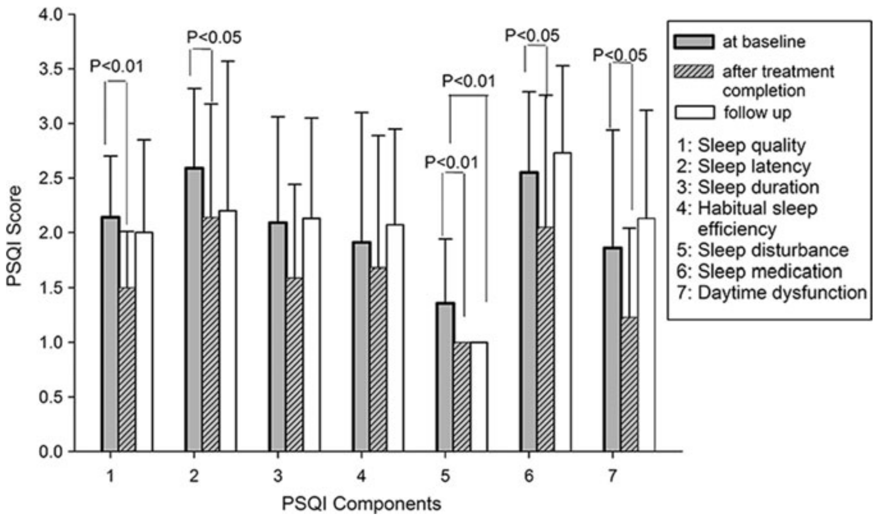

FIG. 3. Comparisons of PSQI component scores (means ± standard error of the mean) between different time points. Significant differences compared with baseline are shown as $p < 0.05$, or $p < 0.01$.

blind the nurses by giving the points as specified codes (numbers or letters) and limiting their interaction with patients. Additional randomized controlled trials should be conducted with appropriate control groups and sufficient blinding.

The mechanism of AAT on sleep quality in MHD patients has not been well studied. However, hypotheses on its mechanism can be based on inferences from results of studies on pharmacy and acupuncture. One hypothesis prevalent in this field attributes the mechanism to the autonomic nervous system. More and more studies claim that auricular acupoints, especially *shen men,* are connected to modulation of autonomic nervous system.[37–42] For example, Lu Wang's study group demonstrated a significant decrease in heart rate and increase in heart rate variability after electronic stimulation of ear *shen men*.[43,44] The effect of reducing blood pressure and heart rate and increasing heart rate variability could be interpreted as depressed sympathetic activity and activated parasympathetic nerves. Some summarized this effect as vagal activity regulation and proposed ''auriculovagal afferent pathway'' as a mechanism.[45] Although insomnia seemed to be associated with sympathetic hyperactivity, [20] the link from vagal regulation by auricular acupressure stimulation to sleep-promoting effect needs further validation. The other hypotheses on the mechanism focused on some mediators influencing physiology of sleep, such as downregulation of hypothalamic γ-aminobutyric acid (GABA) and GABA type A receptors,[46] increase of β-endorphin, melatonin secretion, and nitric oxide in the brain and the blood.[47–49] The planned future study might use appropriate monitoring equipment to collect measures of sleep quality and detect critical biomarkers to investigate the way AAT works.

The present work had several methodologic limitations. First, the lack of a control group and randomization weakens the results. This pilot study simply demonstrated the potential effect of AAT but did not prove its efficacy. Rigorous trials are required to clarify this issue. Second, the sample size was small and the follow-up short. However, the study produced critical data to determine the effect size, clinical relevance, and sample size calculation. Future research should include control of confounding variables, suitable control group, appropriate concealment and randomization, and sufficient sample size and follow-up.

In conclusion, AAT could be an alternative or complement to improve sleep quality for MHD patients with severe insomnia. A strictly designed randomized controlled trial is needed to clarify the effectiveness of AAT.

Acknowledgments

This work was supported by Construction Project from Research Studio of Famous Old TCM Practitioners Experience Heritage, State Administration of Traditional Chinese Medicine (no. 2012KT1301), Research Project for Practice Development of National TCM Clinical Research Bases, China.

Author Disclosure Statement

No competing financial interests exist.

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