ORIGINAL RESEARCH

Acupressure therapy for insomnia in adolescents: a polysomnographic study

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Background: The purpose of this study was to assess the efficacy of acupressure therapy in a sample of adolescents with insomnia using a standard polysomnographic evaluation.

Methods: For this study, 25 adolescents affected by psychophysiological insomnia (mean age 15.04 ± 1.18 years, 12 boys) were enrolled. A device known as the Sea-Band® was used by the patients in order to improve their symptoms related to difficulty in falling asleep. All subjects enrolled underwent two sets of consecutive overnight polysomnographic studies in the Sleep Laboratory of the Clinic of Child and Adolescent Neuropsychiatry, comprising two studies at baseline (before treatment) and another two studies at the end of 6 months of treatment.

Results: At the end of 6 months of treatment, there was a significant increase in all macrostructural parameters of sleep duration, and a reduction in sleep onset latency, wake after sleep onset, and stage 2 sleep. Moreover, the study group showed a significant increase in percent sleep efficiency ($P < 0.001$) and in slow wave sleep representation.

Conclusion: Acupressure is a noninvasive, safe, and effective method for the management of insomnia in adolescents, with good compliance and no adverse effects.

Keywords: insomnia, adolescence, acupressure, polysomnography

Introduction

In clinical practice, sleep disturbances are a frequent reason for pediatric consultation,[1] and may be organic in nature (eg, obstructive sleep apnea) or behavioral (ie, limit setting disorder, sleep onset association, insomnia).[2] However, when unrecognized, the problem can become chronic and increase the risk of behavioral[3] and/or organic abnormalities.[4,5] In fact, the presence of sleep disturbances during infancy may be considered as predictive of subsequent emotional or behavioral problems during adolescence.[6,7] In general, insomnia seems to be one of the most common sleep complaints, with a prevalence of 40% in adulthood,[8] and about 40% of adolescents report some form of sleep problem, including issues of sleep apnea, snoring, and sleep difficulty.[9–11]

Compared with prepubertal youth, adolescents seem to need more sleep, spend less time in slow wave sleep and latency to rapid-eye-movement (REM) sleep, and have a propensity for delayed sleep phase syndrome. In addition, social factors, including early school start times, after-school employment, and extracurricular activities contribute to limited sleep and disrupted sleep patterns, making adolescents vulnerable to excessive sleepiness. Poor sleep adversely affects cognitive function, academic performance, and attentive ability,[12–14] and is associated with poor emotional and physical health[3,15] conduct problems, and substance use.[16–19]

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Moreover, adolescents tend to report insomnia as the most frequent sleep disorder, described as disorders of initiating and maintaining sleep, restless sleep, resistance at bedtime, cosleeping, alterations of sleep hygiene, and early awakening in the morning associated with headache.[20]

Insomnia can be treated with medication, herbal therapy, and psychologic or physical therapy. Commonly used medications include hypnotic/sedative drugs, but may have adverse effects, including impairment of memory, drug resistance, dependency, and addiction.[21] Among the nondrug therapies for insomnia, acupressure, a method used for over 5000 years in Eastern medicine, is becoming increasingly popular worldwide.

According to Eastern medicine, there is an equilibrium between the bipolar forces of Yin and Yang, and disease can result from disruption of such equilibrium. Acupuncture and acupressure are believed to restore equilibrium. Acupressure involves using the fingers, thumbs, palms, heels of the hand, and elbows to apply pressure and stimulate specific points along the meridians (or energy channels) of the body. Acupressure is rapidly gaining acceptance as a safe, cost-effective, noninvasive, and nonpharmacological form of therapy.[22] Use of acupressure is based on stimulation of meridians, a network of energy pathways throughout the body, to increase the flow of so-called "qi" (bioenergy), subsequently altering the experience of symptoms.[23] Acupressure is applied to specific points using the finger, hand, elbow, foot, and/or an acupressure Sea-Band® (Sea-Band, Leicestershire, UK) which stimulates these pathways and increases the flow of qi. Studies have suggested the efficacy of acupressure therapy in sleep regulation[24] and, in particular, acupressure at the HT-7 (Shen Men) point seems to have a therapeutic effect in patients with disorders of initiating and maintaining sleep.[21]

In the clinical literature, there are also several reports of the efficacy of acupressure therapy in various other conditions, including nocturnal enuresis,[25] body weight and serum lipid levels,[26] and migraine-associated nausea,[27] which may be associated with sleep disorders.[4,20,28] The aim of the present study was to assess the efficacy and safety of an HT-7 point acupressure system when used to treat insomnia in adolescents using a standard polysomnographic evaluation.

Materials and methods
Study population
Twenty-five adolescents affected by psychophysiological insomnia (12 boys, 13 girls, mean age 15.04 ± 1.18 years) were enrolled in this study. The Sea-Band device was given to the patients in order to improve their symptoms related to difficulty falling asleep. The Sea-Band is an elastic wrist-band with a 1 cm protruding round plastic button, and the device applies continual pressure to the HT-7 acupuncture point with the aim of decreasing or completely eliminating insomnia. The HT-7 point is located on the wrist, at the ulnar end of the transverse crease of the wrist, in the depression on the radial side of the flexor carpi ulnaris tendon. Sea-Bands were applied bilaterally at the Shen Men point on both wrists, starting from the usual bedtime (10 pm) to the usual awakening time (7 am) every night for a period of 6 months.

All enrolled subjects underwent consecutive overnight polysomnographic studies in the Sleep Laboratory of the Clinic of Child and Adolescent Neuropsychiatry, comprising two at baseline (before treatment) and another two at the end of 6 months of treatment. The results obtained from the first night at baseline and at the end of 6 months of treatment were not included in the analysis to avoid the "first-night" effect.[29]

All subjects were recruited from the same urban area, were of Caucasian origin, and of middle class socioeconomic status. An initial screening interview was carried out by a child and adolescent neuropsychiatrist. A preliminary diagnosis for inclusion in the study was made according to International Classification of Sleep Disorders (ICSD-2) criteria. The subjects had to report having at least two symptoms of insomnia (fragmented sleep, frequent awakenings, early morning awakenings followed by an inability to fall back to sleep, or feeling tired in the morning despite having spent a normal period of time in bed) for at least 2 years beforehand, which were not related to an obvious environmental stressor. Potential participants with any concurrent medical, psychological, or psychiatric factors which might account for their sleep difficulties were excluded. Other exclusion criteria were presence of other sleep disorders, history of alcohol or drug abuse, current treatment with psychoactive drugs, or concurrent psychotherapy.

All evaluations were performed after informed consent was obtained from the parents, according to the Declaration of Helsinki as revised in 2000. The study was approved by the departmental ethics committee of the Second University of Naples.

Polysomnographic sleep recordings
As previously reported in other polysomnographic studies,[14,30] electroencephalographic (EEG) recordings and electrode placement were performed according to the 10–20 system[31] and the polysomnographic montage included at least

19 EEG channels (Fp2, Fp1, F3, F4, F7, F8, C3, C4, T3, T4, P3, P4, T5, T6, O1, O2, Fz, Cz, Pz) referenced to the contralateral mastoid, left and right electro-oculogram, chin electromyogram, left and right tibialis electromyogram, electrocardiogram (one derivation), nasal cannula, thorax and abdominal effort, peripheral oxygen saturation, pulse, and position sensors.

The recordings were carried out using a Brain Quick Micromed System 98 recording machine, and signals were sampled at 256 Hz and stored on a hard disk for further analysis. EEG signals were digitally band-pass filtered at 0.1–120 Hz, with 12-bit A/D precision. Sleep signals were sampled at 200 Hz or 256 Hz and stored on a hard disk in European data format[32] for further analysis. EEG signals were first acquired with a wide band analog filter (0.001–70 Hz) and then digitally band-pass filtered at 0.1–50 Hz. All recordings started at the subjects' usual bedtime and continued until spontaneous morning awakening.

Sleep stage scoring

Sleep was subdivided into 30-second epochs, and sleep stages were scored using standard criteria.[33] The following conventional sleep parameters were evaluated:

- Time in bed
- Sleep period time: time from sleep onset to end of sleep
- Total sleep time: time from sleep onset to the end of the final sleep epoch minus time awake
- Sleep latency: time from lights out to sleep onset, defined as the first of two consecutive epochs of stage 1 sleep or one epoch of any other stage, in minutes
- REM latency: time from sleep onset to the first REM sleep epoch
- Number of stage shifts/hour
- Number of awakenings/hour
- Sleep efficiency: percentage ratio between total sleep time and time in bed (total sleep time/time in bed * 100)
- Percentage of sleep period time spent in wakefulness after sleep onset, ie, time spent awake between sleep onset and end of sleep
- Percentage of sleep period time spent in sleep stages 1 (S1%) and 2 (S2%), slow-wave sleep (SWS%), and REM sleep (REM%).

All variables were analyzed by Hypnolab 1.2 sleep software analysis (SWS Soft, Troina, Italy). All recordings were visually scored by one of the investigators (MC), and the sleep parameters derived were tabulated for statistical analysis.

In order to exclude the presence of sleep-related breathing disorders, nocturnal respiratory parameters (ie, central, obstructive, and mixed apnea events) were counted using standard criteria.[34] The apnea-hypopnea index was defined as the number of apneas and hypopneas per hour of total sleep time; an obstructive apnea index > 5 was selected as the cutoff for normality.[35,36]

Standard criteria were used to identify episodes of periodic limb movements. The frequency of leg movements was represented as the periodic leg movement index (number/hour of total sleep time). Episodes of periodic limb movements were defined as leg movements with an amplitude increase of 8 μV above the baseline value, a duration of 0.5–10 seconds, a period length between two consecutive movements of 5–90 seconds, and a minimum of four consecutive movements.[37] A periodic leg movement index ≥ 5 was considered abnormal.

Statistical analysis

Comparisons between differences in sleep architecture at baseline and at the end of 6 months of treatment in insomniac subjects on Sea-Band therapy were done using the analysis of variance test. P values < 0.05 were considered to be statistically significant. The commercially available software Statistica version 6 (StatSoft Inc, Tulsa, OK) was used for all statistical tests. Statistical power was estimated using software for analysis available online (http://www.dssresearch.com/toolkit/spcalc/power.asp) for the polysomnographic findings at baseline and at the end of 6 months of treatment. The alpha error level of the confidence interval was 5%.

Results

As shown in Table 1, at the end of 6 months of treatment, the study sample showed a significant increase in all macrostructural parameters of sleep duration (time in bed 526.680 ± 65.642 minutes, sleep period time 506.626 ± 66.170 minutes, and total sleep time 437.957 ± 68.344 minutes) compared with baseline [time in bed 458.760 ± 58.397 minutes ($P = 0.01$), sleep period time 422.188 ± 55.142 minutes ($P < 0.01$), and total sleep time 336.352 ± 59.893 minutes ($P < 0.001$)]. Moreover, after 6 months of acupressure therapy, insomniac subjects reveal a reduction in sleep onset latency (36.572 ± 13.217 minutes versus 20.054 ± 12.132 minutes, $P < 0.001$), in wake after sleep onset (sleep period time [spt] 20.645 ± 6.719 minutes versus 13.763 ± 4.480 minutes, $P < 0.001$) and in Stage 2 (S2) representation (S2-spt 32.331 ± 6.119 minutes versus 22.901 ± 4.335 minutes, $P < 0.001$; S2-total sleep time [tst] 40.704 ± 6.836 minutes versus 26.500 ± 4.572 minutes, $P < 0.001$).

Table I Comparison of sleep macrostructural characteristics in insomniac subjects at baseline and after 6 months of treatment with the Sea-Bands® HT-7 system

	T0 n = 25	T1 n = 25	P
TIB-min	458.760 ± 58.397	526.680 ± 65.642	0.010
SPT-min	422.188 ± 55.142	506.626 ± 66.170	<0.01
TST-min	336.352 ± 59.893	437.957 ± 68.344	<0.001
SOL-min	36.572 ± 13.217	20.054 ± 12.132	<0.001
FRL-min	138.976 ± 77.132	125.078 ± 69.419	NS
SS-h	12.924 ± 2.568	12.278 ± 2.440	NS
AWN-h	6.828 ± 2.048	6.145 ± 1.843	NS
SE%	72.983 ± 5.912	82.930 ± 5.060	<0.001
WASO-min	85.836 ± 26.948	68.669 ± 21.558	NS
S1-min	14.360 ± 10.384	12.206 ± 8.826	NS
S2-min	137.184 ± 35.503	116.606 ± 30.177	NS
SWS-min	108.876 ± 22.694	225.619 ± 28.986	<0.001
REM-min	75.932 ± 30.780	83.525 ± 33.858	NS
WASO-spt	20.645 ± 6.719	13.763 ± 4.480	<0.001
S1%	3.479 ± 2.684	2.464 ± 1.901	NS
S2%	32.331 ± 6.119	22.901 ± 4.335	<0.001
SWS%	25.944 ± 5.477	44.737 ± 4.467	<0.001
REM%	17.601 ± 6.098	16.134 ± 5.590	NS
S1-tst	4.461 ± 3.557	2.884 ± 2.272	NS
S2-tst	40.704 ± 6.836	26.500 ± 4.572	<0.001
SWS-tst	32.909 ± 7.683	52.067 ± 6.497	<0.001
REM-tst	21.926 ± 6.852	18.549 ± 6.003	NS

Notes: An analysis of variance test was performed. P values < 0.05 were considered to be statistically significant.
Abbreviations: NS, not significant; min, minutes; TIB, time in bed; SPT, sleep period time; TST, total sleep time; SOL, sleep onset latency; FRL, first REM sleep latency; SS, stage shifts; AWN, awakenings; SE, sleep efficiency; WASO, wake time after sleep onset; S1, sleep stage 1; S2, sleep stage 2; SWS, slow-wave sleep; REM, rapid eye movement sleep percentage; T0, baseline; T1, after 6 months of treatment.

Moreover, the study group show a significant increase in sleep efficiency (SE)% ($72.983 ± 5.912$ versus $82.930 ± 5.060$, $P < 0.001$) and in SWS representation (SWS-min $108.876 ± 22.694$ versus $225.619 ± 28.986$, $P < 0.001$; SWS-spt $25.944 ± 5.477$ versus $44.737 ± 4.467$, $P < 0.001$; and SWS-tst $32.909 ± 7.683$ versus $52.067 ± 6.497$, $P < 0.001$, Table 1).

The statistical power calculated showed the following values: 100% for total sleep time-minutes, percent sleep efficiency, SWS-minutes, S2%, SWS%, S2-total sleep time, SWS-total sleep time, 99.9% for the sleep period time-minutes, 99.8% for the sleep onset latency-minutes, and 98.3% for the time in bed-minutes.

Discussion

Sleep is a vital physiological process with important restorative functions. Notable quantitative and qualitative changes in sleep occurring with age include more sleep fragmentation, earlier awakening, and reduced slow wave sleep. Age-related changes in the distribution of sleep cycles represent only a small piece of the complex array of chronobiological changes in physiological systems that accompany the aging process. Alternation between wakefulness and sleep, as well as the structure of sleep itself, are regulated by the interaction of outputs of the endogenous circadian pacemaker,[38] located in the suprachiasmatic nucleus of the hypothalamus,[39,40] and the homeostatic process.[41,42]

Moreover, the homeostatic process is thought to reflect the need for sleep which builds up during sustained wakefulness and dissipates during sleep. Slow wave sleep and slow wave activity, ie, EEG power density in the 0.75–4.5 Hz range, are considered to be markers of this process because they exhibit a predictive quantitative relationship with the duration of wakefulness and sleep.[43] In this respect, the increasing time spent in slow wave sleep and the reducing sleep fragmentation (expressed by reduction in wake after sleep onset) in our sample could be interpreted as direct signs of improved sleep quality.

On the other hand, adolescents require more sleep than prepubertal youngsters, but frequently get less sleep than they need. Transition to an earlier school start time, along with sleep phase delay, significantly affects sleep quality, the sleep/wake schedule, and daytime behavior in teenagers. The combination of phase advance, late-night activities or jobs, and early morning school demands can significantly reduce the time available for sleep. In light of such considerations, the efficacy of HT-7 acupressure in improving the total sleep time in our sample could represent improvement in activation of the neuroendocrine system linked to sleep efficiency (ie, melatonin secretion) which is essential for cognition,[14] mood regulation,[3] and quality of life according to developmental age.

It is reasonable to say that complaints of insomnia may go unheeded either because of under-reporting to parents or lack of specialized prevention and early detection health programs, which seem to be of great importance and for which there is a pressing need. The confidentiality of our data collection enabled this need to emerge, and it would be important to promote a similar climate in any attempt to address this kind of problem in the future. Confidentiality is particularly important for adolescents, given that this age is, by definition, a time of fragility and vulnerability, making the adolescent reluctant to acknowledge any problems which could be perceived as faults and be unwilling to seek appropriate help.[44] Therefore, acupressure could be considered as a noninvasive, safe, and effective method to treat insomnia with good compliance and no adverse effects.

The strength of our findings lies in the use of gold standard polysomnography for assessment of sleep alterations in order to circumvent subjective reporting by patients. The main limitation of our study is the size of the study population and the subjects being recruited from the same urban area. Notwithstanding this limitation, our results suggest that acupressure could be a safety, effective, and cost-effective therapy for the management of psychophysiological insomnia in adolescence, even if future sources are needed.

Acknowledgment

Disclosure

The authors report no conflicts of interest in this work.

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