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ORIGINAL ARTICLE

Avoiding the supine position during sleep lowers 24 h blood pressure in obstructive sleep apnea (OSA) patients

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Obstructive sleep apnea (OSA), is a common clinical condition affecting at least 2–4% of the adult population. Hypertension is found in about half of all OSA patients, and about one-third of all patients with essential hypertension have OSA. There is growing evidence that successful treatment of OSA can reduce systemic blood pressure (BP). Body position appears to have an important influence on the incidence and severity of these sleep-related breathing disturbances.

We have investigated the effect of avoiding the supine position during sleep for a 1 month period on systemic BP in 13 OSA patients (six hypertensives and seven normotensives) who by polysomnography (PSG) were found to have their sleep-related breathing disturbances mainly in the supine position. BP monitoring was performed by 24-h ambulatory BP measurements before and after a 1 month intervention period. We used a simple, inexpensive method for avoiding the supine posture during sleep, namely the tennis ball technique.

Of the 13 patients, all had a reduction in 24-h mean BP (MBP). The mean 24-h systolic/diastolic (SBP/DBP) fell by 6.4/2.9 mm Hg, the mean awake SBP/DBP fell by 6.6/3.3 mm Hg and the mean sleeping SBP/DBP fell by 6.5/2.7 mm Hg, respectively. All these reductions were significant (at least $P < 0.05$) except for the sleeping DBP. The magnitude of the fall in SBP was significantly greater in the hypertensive than in the normotensive group for the 24 h period and for the awake hours. In addition, a significant reduction in BP variability and load were found. Since the majority of OSA patients have supine-related breathing abnormalities, and since about a third of all hypertensive patients have OSA, avoiding the supine position during sleep, if confirmed by future studies, could become a new non-pharmacological form of treatment for many hypertensive patients.

Keywords: obstructive sleep apnea; ambulatory blood pressure monitoring; sleep position; body posture

Introduction

Obstructive sleep apnea (OSA) is a clinical entity characterised by intermittent partial or complete collapse of the upper airway during sleep.[1–3] Studies over the last few years have shown that the prevalence of essential hypertension is much higher in patients with OSA (50%)[4–7] than it is in the general population (20%).[8] Conversely, the prevalence of OSA is much higher in patients with essential hypertension (30%)[9–12] than it is in the general population (2–4%).[13] As summarised by ourselves recently,[14,15] there is growing evidence from many[16–19] but not all[20,21] epidemiological studies, that OSA is an independent risk factor for the production of hypertension. In addition, many retrospective[4,6,11] and most[22–25] but not all[21,26,27] prospective trials of therapy of OSA have demonstrated that its successful treatment is associated with a fall in awake, sleeping and 24-h blood pressure (BP).

The treatment of choice for OSA is nasal continuous positive airway pressure (nCPAP).[1–3] However, the long term compliance with nCPAP is often disappointing.[28] Other methods of treatment of OSA include weight reduction,[29] use of oral devices that advance the mandible and/or the tongue[30] and different surgical interventions of which the most popular is uvulopalatopharyngoplasty (UPPP).[31] Although weight reduction, when achieved, is effective in improving or even curing many overweight OSA patients,[29] the long term compliance with this form of therapy is often poor.[32] There is insufficient long term data available on the efficacy and side effects of the use of oral devices.[30] Despite much experience with UPPP, it has proven difficult to predict which patients will benefit from the procedure and which will not.[31]

Another less popular method of treating OSA is by avoiding sleeping in the supine position (positional therapy).[33] As shown by others,[34,35] and more recently in a large population by ourselves,[36] more than 50% of OSA patients have at least twice as many sleep-related breathing disturbances when they sleep on their back as when they sleep on their side. Thus, in these patients, the degree of severity of OSA is mostly dependent upon on the amount of time that they sleep in the supine posture. In

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addition, the severity of these episodes; ie, their length, the magnitude of both the oxygen desaturations and the arousal-related responses are usually worsened by sleeping on the back.[37] By avoiding the supine position, these patients can relieve these disturbances to a great extent and in some cases even entirely.[33,38]

The aim of this study is to assess the effect of avoiding the supine position during sleep over a 1 month period on the 24-h BP in 13 OSA positional patients, ie, those who were found during a polysomnographic (PSG) evaluation to have most of their sleep-related disturbances when they lay on their back.

Subjects and methods

Subjects

Eighteen consecutive OSA patients who fulfilled the inclusion criteria were studied. The following inclusion criteria were used. Patients who were diagnosed as having OSA (respiratory disturbance index—the number of apneas + hypopneas/sleep hour (RDI) $\geqslant$ 10), were older than 20 years of age and had a back/side RDI ratio $\geqslant$2 (ie, positional patients). Exclusion criteria included OSA patients who slept less than 30 min in either the supine or lateral body position, or had ischaemic heart disease, congestive heart failure, chronic obstructive pulmonary disease or renal disease.

Five of the 18 OSA patients were eventually excluded from the study because they failed to complete the intervention protocol. Two patients were dropped from the study because they did not comply with the tennis ball technique (*see* Method for avoiding the supine position during sleep). One other patient refused to continue the study after 1 week because of her inability to fall asleep while lying on her side. Another patient preferred to begin nCPAP therapy after a few days of the tennis ball therapy, and the last patient was unable to avoid the supine position with one tennis ball, one baseball and even two baseballs.

Anthropometric data on the 13 patients who completed the study are seen in Table 1. The mean age was 51.8 ± 7.7 years (range 37–65). The male/female ratio was 11:2. The mean weight was 84.1 ± 17.0 kg (range 57–113). Three of the patients had a BMI (body mass index; kg/m^2) <25. The mean BMI was 28.31 ± 4.22 (range 21.3 –37.3).

Patients' BP status

Hypertension was defined as either: (a) patients on antihypertensive medications; (b) mean systolic BP (SBP) during awake hours of >140 mm Hg, as measured by ambulatory BP monitoring (ABPM); or (c) mean diastolic BP (DBP) during awake hours of >90 mm Hg.[39,40] Using these criteria, six patients (46.2%) were hypertensive and the other seven (53.8%) were normotensive. Out of the six hypertensive patients, four (66.7%) were receiving antihypertensive therapy. Two of the treated hypertensive patients still had elevated BP despite therapy (see Table 1).

Polysomnographic (PSG) evaluations

All the patients were referred to the Sleep Disorders Unit at the Loewenstein Rehabilitation Center because of snoring complaints and/or a suspicion of OSA. The patients arrived at the sleep unit around 20.00 and the PSG recordings usually began between 22.00 and midnight.

The PSG recordings were carried out using Nihon Koden polygraphs—models 4321 and 4414, and include the following parameters: electrooculogram (EOG) (2–4 channels); electroencephalogram (EEG) (4–6 channels); electromyogram (EMG) of sub-mental muscles (1–2 channels); ECG (1 channel); EMG of the anterior tibialis muscle of both legs (1–2 channels) and airflow (with a thermistor, Nihon Koden, Japan). Chest and abdominal effort (2 channels) were recorded using inductive plethysmography (Respitrace, Ambulatory Monitoring Inc, Ardsley, NY, USA; or Resp-Ez breathing belts, Tel Aviv, Israel); SaO_2 levels (1 channel) by pulse oximetry (Ohmeda 3700e, Boulder, CO, USA) with a finger probe, and audio (1 channel) by a microphone located above the patient's head at a distance of 1 m and connected to a sound level meter (SLM) (Quest Electronics—model 2700, Oconomowoc, WI, USA).

The output from the SLM was also recorded in parallel on a calibrated (40–80 db) chart recorder at a paper speed of 10 cm/hr. The PSG recordings were carried out at a paper speed of 10 mm/sec and sleep stages were scored according to the standard criteria of Rechtschaffen and Kales.[41]

The polysomnographic technician who followed the patient's behaviour through a closed circuit 21 inch TV monitor, marked the changes in body position in two places simultaneously, on the polygraph and on the chart recorder which registered the output of the pulse oximeter data. The polysomnographic technician was responsible for the monitoring of one or two sleeping patients. The two TV monitors were placed side by side to allow easy visualisation of all patients' body movements. Since our unit is especially interested in the effect of body position on sleep-related breathing disturbances, our PSG technicians are encouraged to pay special attention to this issue.

Apnea was defined as an episode of a complete breathing cessation of 10 sec or longer. Hypopneas were considered as such if a partial breathing cessation (more than a 20% reduction in oral/nasal airflow compared with the level of the previous five breaths) occurred, accompanied by a drop of SaO_2 of at least 3%.

Apnea index (AI) and RDI were calculated as the number of apneas/sleep per hour and the number of apneas + hypopneas/sleep per hour, respectively. Periodic leg movements (PLM), PLM index (PLMI) and PLM arousal index (PLMAI) were scored and calculated according to Coleman.[42]

Ambulatory BP monitoring (ABPM)

ABPM was performed by a non-invasive portable recorder (Accutracker II, Suntech Medical Instruments, Raleigh, NC, USA). The device was set up to

Table 1 Anthropometric data, BP status/treatment and respiratory disturbance index (RDI) values of the 13 OSA patients who were treated by the tennis ball technique for a 1 month period

No.	*Age*	*Sex*	*Weight (kg)*	*BMI*	*Blood pressure status*	*Treatment*	*Respiratory Disturbance Index*			
							Total	*Back*	*Side*	*Back/side ratio*
1	63	M	73	25.6	NT		33.4	75.6	9.4	8.0
2	59	M	100	30.2	known HT	Nifedipine	40.3	70.7	12.7	5.6
3	45	F	87	32.3	known HT	Thiazide, Prazosin	63.8	93.3	22.5	4.1
4	65	M	65	22.0	known HT	Thiazide, ACE inhibitor	26.5	40.0	20.0	2.0
5	49	M	97	29.9	unknown HT		43.0	74.3	37.0	2.0
6	57	F	57	25.3	NT		17.5	31.2	4.3	7.3
7	53	M	110	31.8	NT		29.7	69.0	15.0	4.6
8	44	M	113	37.3	NT		22.5	35.1	6.7	5.2
9	49	M	97	31.6	known HT	Bisoprolol	10.4	15.8	5.3	3.0
10	47	M	78	27.0	NT		12.4	16.8	4.8	3.5
11	37	M	63	21.3	NT		20.4	50.1	6.8	7.4
12	56	M	68	24.4	NT		27.5	48.0	10.4	4.6
13	49	M	85	29.4	unknown HT		42.5	56.5	16.9	3.3

BMI = body mass index; NT = normotensive; HT = hypertensive; ACE: angiotensin-converting enzyme; RDI = number of apneas + hypopneas/sleep hour.

record BP every 30 min during the hours 07.00 to 23.00 and every 60 min during the hours 23.00 to 07.00.

The BP data were visually edited to eliminate artifacts not picked by by the device.

Intervention protocol

The basic intervention protocol was the recording of 24 h ABPM before and after 1 month of avoiding the supine position during sleep by the tennis ball technique. Patients were asked not to change their diet, including caloric and salt intake, medication, or physical activities during the 1 month intervention period. None of the patients used night time sedation drugs before or during the study and none consumed alcohol except in minimal amounts once a week during the Sabbath religious ceremony. Weight was measured at the beginning and at the end of the study and BMI values were calculated.

Method for avoiding the supine position during sleep: the tennis ball technique

Each patient was given a wide cloth belt which had a pocket into which a tennis ball was placed. This belt was wrapped around the chest at the level of the armpits so that the pocket with the ball lay in the middle of the back. Whenever the patients rolled onto their backs, they felt the pressure of the tennis ball and rolled onto the side again.

To assess the compliance with this therapy, we phoned the patients on the 10th and 20th day of the study to inquire if they were continuing to use the belt successfully. At the end of the 30-day period of wearing the tennis ball belt every night, the patients and their partners were personally interviewed again to evaluate the effectiveness of this technique in keeping the patients off their backs during sleep. The wake/sleep hours on the day of BP measurements were recorded by the patients in a sleep diary. In addition, during the entire intervention period, the patients were asked to record on a daily basis whether they used the tennis ball technique or not.

Data and statistical analysis

BP data were edited to eliminate artifacts not picked up by the device. The average value of awake, sleep and 24-h SBP, DBP and mean BP (MBP, considered as DBP + 1/3 (SBP–DBP)) were calculated. BP load was defined as the percentage of SBP values >140 or DBP values >90 mm Hg in the awake period and SBP of >120 and DBP >80 mm Hg during the sleep period.[39,40] BP variability was defined as the standard deviation of the average of all 24 h, awake and sleep MBP values.[43,44] A BP dipper was defined as a patient whose MBP during sleep hours was at least 10% lower than the MBP during the awake hours. A BP non-dipper was defined as a patient whose MBP during sleep hours fell by less than 10% compared to the MBP during the awake hours.[45] Heart rate (HR) variability was defined as the standard deviation of the awake, sleep and 24-h HR values.[43,44,46]

Data analysis was performed using the SPSS statistical package, version 6.0. We used a two-tailed, paired Student's t-test for the comparison of the various parameters before and after the intervention. $P < 0.05$ was considered significant.

Results

Weight

The mean weight before and after intervention was unchanged: 84.1 ± 17.0 and 84.0 ± 16.9 kg respectively. No patient changed in weight by more than 2.0 kg in any direction. Consequently, no significant changes in the BMI were seen: 28.31 ± 4.22 to 28.30 ± 4.21 (see Table 1).

Polysomnographic data

The values for RDI sleeping on the back and on the side, and back/side ratio are seen in Table 1. The

Table 2 Summary of 24-h, awake and sleep systolic BP, diastolic BP, mean BP and heart rate data before and after avoiding the supine position during sleep for 1 month in 13 positional OSA patients

Period	*BP parameter*	*Before treatment*	*After treatment*	*Change in BP (Before-After)*	*P value*
24-h	Systolic BP	133.3 ± 6.6	126.9 ± 4.1	6.4	0.001
	Diastolic BP	78.3 ± 4.1	75.3 ± 2.9	2.9	0.006
	Mean BP	96.3 ± 4.3	92.2 ± 2.8	4.1	0.001
	Heart Rate	73.6 ± 9.6	71.0 ± 8.4	2.6	0.278
Awake	Systolic BP	137.8 ± 5.6	131.2 ± 4.2	6.6	0.001
	Diastolic BP	81.3 ± 3.8	78.0 ± 3.3	3.3	0.002
	Mean BP	99.8 ± 3.7	95.4 ± 3.0	4.4	0.001
	Heart Rate	76.0 ± 10.0	73.1 ± 8.8	2.9	0.269
Asleep	Systolic BP	115.8 ± 11.8	109.3 ± 9.4	6.5	0.022
	Diastolic BP	66.8 ± 7.2	64.1 ± 6.6	2.7	0.102
	Mean BP	82.8 ± 7.9	78.9 ± 7.3	3.9	0.027
	Heart Rate	64.8 ± 9.4	62.3 ± 9.2	2.5	0.093

Values are mean ± s.d. All BP values are in mm Hg.

high back/side ratio attests to the strong effect of position on the sleep-related breathing disturbances. Six out of the 13 patients, had a normal RDI (<10) while sleeping on their side. One patient had an increased number of PLMs (PLM index = 37) and PLMs that produced arousals (PLMAI = 28) (PLMAI >25 is considered severe). This patient had the least change in BP of any of the patients (patient no. 7 in Table 1).

BP data

Number of patients with changes in BP:
(1) *24 h BP*: Of the 13 patients all had a reduction in MBP, 12 in SBP and 11 in DBP.
(2) *Awake BP*: All 13 had a reduction in MBP, 12 in SBP and 12 in DBP.
(3) *Sleep BP*: Eight had a reduction in MBP, 10 in SBP and nine in DBP.

Changes in BP values: The changes in BP values are seen in Table 2 and Figure 1. The reduction in BP was significant for 24-h SBP, DBP and MBP, for awake SBP, DBP and MBP and for sleep SBP and MBP. Only the fall in DBP during sleep did not reach significance although there was a trend in this direction ($P = 0.102$).

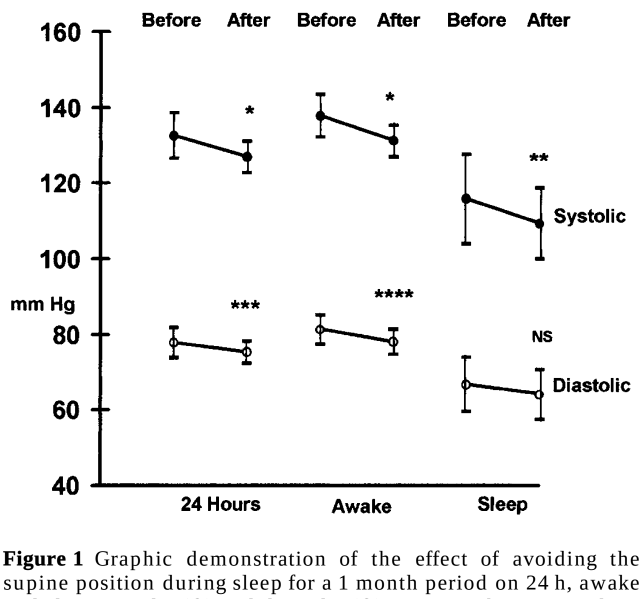

Figure 1 Graphic demonstration of the effect of avoiding the supine position during sleep for a 1 month period on 24 h, awake and sleep systolic (●) and diastolic (○) BP in 13 obstructive sleep apnea (OSA) patients. (*$P = 0.001$; **$P = 0.022$; ***$P = 0.006$; ***$P = 0.002$; NS = non-significant. Values are mean ± s.d.)

BP changes in hypertensives vs normotensives: - The hypertensive group had greater falls in all BP parameters than the normotensive group, although these only reached statistical significance for 24-h SBP (9.30 *vs* 2.74 mm Hg) ($P < 0.02$) and awake SBP (10.70 *vs* 3.09 mm Hg) ($P < 0.001$).

Changes in BP load: The data on BP load are seen in Table 3. Awake and sleep SBP and DBP load fell significantly.

Dippers vs non-dippers: Intervention caused no significant differences in the number of non-dippers (ie, those with <10% drop in mean sleep BP compared to mean awake BP). Three out of the 13 patients (23.1%) were non-dippers before the intervention and two of these patients (15.4%) remained non-dippers afterwards.

BP variability: The 24-h MBP and awake MBP variability fell significantly from 12.7 ± 2.0 to 10.7 ± 2.2 ($P = 0.007$) and from 10.4 ± 1.9 to 8.4 ± 1.9 ($P = 0.006$), respectively. These reductions represent a fall of 15.7% and 19.2%, respectively. The sleep MBP variability fell from 7.6 ± 2.3 to 7.2 ± 1.6 but this fall was not significant ($P = 0.65$). Nevertheless, BP variability expressed as variation coefficients showed that the changes observed for the 24 h, (0.13 ± 0.02 to 0.11 ± 0.02) as well as for the sleep period (0.09 ± 0.04 to 0.09 ± 0.02) were not significant ($P = 0.103$ and $P = 0.887$, respectively). However, for the awake period these changes were still significant (0.10 ± 0.02 to 0.09 ± 0.02; $P = 0.027$).

Correlation between BP and sleep parameters: No significant correlations were found between any of the sleep parameters and any changes in BP (data not shown).

Table 3 BP load data for the awake and sleep periods before and after avoiding the supine position during sleep for 1 month in 13 positional OSA patients

Period of BP measurement	*Parameter*	*Before*	*After*	*P value*
Awake	% SBP >140	38.2 ± 18.3	19.7 ± 11.3	<0.001
	% DBP >90	18.2 ± 11.9	9.9 ± 8.3	<0.001
Asleep	% SBP >120	35.8 ± 34.4	17.8 ± 24.3	=0.001
	% DBP >80	12.0 ± 18.9	1.6 ± 3.8	=0.031

Heart rate (HR) data

The HR values are seen in Table 2. Although the 24-h, awake and sleep HR values were lower after intervention, the changes were not significant. Nevertheless, the fall in HR during sleep showed a trend towards a reduction ($P = 0.093$). A significant fall in sleep HR variability was observed: 6.6 ± 2.5 to 5.0 ± 1.5 ($P = 0.04$) and this represents a fall of 24.2%. The 24-h and awake HR variability did not change significantly.

Discussion

In this study we have shown that in supine-related OSA patients (positional patients), avoiding the back position during sleep for 1 month caused a significant reduction in MBP, SBP and DBP for the total 24-h period and for the awake hours. For the sleep hours a significant reduction was found for the MBP and SBP but only a trend towards a reduction was observed for the DBP. This fall in BP was greater in hypertensive OSA patients than in normotensives ones. The BP load[39,40] and BP variability,[43,44] both of which may reflect the risk of hypertensive end-organ damage even more accurately than the 24-h BP values, also fell significantly after intervention. Treatment of OSA patients with nCPAP has also been shown to reduce BP load[46] and BP variability.[22,46] The fall in HR variability which was observed in our study during sleep hours, has also been seen after successful nCPAP treatment.[22]

No significant differences in the weight/BMI were seen during the 1 month period for any of the 13 patients that successfully completed the study, therefore the BP changes cannot be due to this factor.

There are several limitations of this study. The major limitation is that we did not have a parallel supine-related OSA patient control group with no intervention. Nevertheless, it is unlikely that the relatively large fall in 24-h BP obtained in this study was due to a placebo effect or due to the patients becoming accustomed to the measurements, since it has been shown repeatedly in hypertensives and normotensives that minimal or no placebo effect exists when the ABPM technique is used[47] and BP values tend to be similar on repeated measurements over weeks or months.[48–50]

Another limitation is the small number of patients in our study, and it is mandatory that these results should be verified in a larger group of patients. Nevertheless, the consistency of the results is striking and suggests that in positional OSA patients, avoiding the back position produces a significant reduction in both awake and sleeping BP values.

Another issue relates to the taking of antihypertensive medications. In the four patients who took these medications, no pill counts were performed in the pre-intervention and intervention period. It is possible that during the intervention period the patients paid more attention to taking their medications. However, as judged by the information obtained in the three interviews with the patients and spouses during the intervention period, this did not appear to be the case.

We did not measure the compliance with the tennis ball technique or its efficiency by visual observation during each night's sleep at home. Nevertheless, all 13 patients who completed the study as well as their partners stated that they used it consistently and successfully, ie, both the patients and their partners reported that the patients did not sleep on their backs at all during the intervention period.

Several studies have criticised the use of ABPM during sleep mainly because of the possible arousal effect of BP measurements on sleep continuity[51–53] and on BP values themselves.[53] Others, however, have found that the ABPM measurements cause no major changes in either sleep architecture[54] or mean sleeping time.[55] Since the ABPM protocol for the pre- and post-intervention measurements was identical, this possible systematic error should affect both groups similarly.

It is interesting to note that the smallest reduction in BP was seen in the patient with frequent PLMs (patient no. 7 in Table 1). These limb movements have been shown to be followed by BP swings which could also contribute to the production of hypertension.[56] Accordingly, the existence of these PLMs could possibly help to explain the small reduction in BP after positional therapy in this patient. Nevertheless, this issue is still controversial.[57]

The decrease in BP resulting from avoiding the supine position during sleep for 1 month was similar to that seen in several other studies using nCPAP treatment.[22–25] In addition, the greater fall in BP seen in the hypertensive group than in the normotensive group consistent with the findings of others.[24,25,58]

In a recent study from our laboratory,[36] we found that, in 574 consecutive adult OSA patients, 55.9% were positional patients and in those with only a mild to moderate degree of severity of OSA, this figure reached 69%. We found that the likelihood of being an OSA positional patient correlates with the

RDI, BMI and age in a general reverse relationship, ie, an OSA patient with a severe RDI and who is obese (BMI >30) and older than age 60 is significantly less likely to be positional than an OSA patient with a moderate RDI who is not obese and who is less than 60 years of age. Therefore in the milder forms of OSA, avoiding the supine position may, in many cases be all that is needed to treat the breathing abnormalities during sleep.

Habitual snoring is very common in patients with essential hypertension.[13,17] In a recent study in our Sleep Disorders Unit, we found that in patients with continuous snoring, the percentage of snoring-related short arousals is significantly higher in the supine position than in the lateral position at all sleep stages.[59] It is therefore possible that many habitual snorers with hypertension, even in the absence of OSA, might be able to reduce their BP by simply avoiding the supine position. We are currently investigating this issue.

Despite the high prevalence of positional dependency in OSA[34–36] and despite the pioneering encouraging results of Cartwright *et al*,[33] it is surprising how few investigations have been carried out on the therapeutic efficacy of avoiding the supine position during sleep in positional patients. Indeed, in some recent reviews on OSA, the role of positional therapy has not even been mentioned.[60,61] One possible reason why this form of therapy has not been widely accepted for the treatment of OSA, is that many positional patients still continue to snore, sometimes loudly, when they sleep in either the lateral or prone position. Consequently, their spouses continue to complain about snoring. Thus, even though in many cases this therapy may clearly improve the quality of sleep[33] and, as has been shown in the present study, may significantly reduce BP, the fact that snoring continues in the lateral or prone positions may limit the long-term effectiveness of this approach. Another possible limitation of positional therapy is that this therapy is not the ideal solution for most severe OSA patients, who have sleep-related breathing abnormalities independent of the sleep position,[34,36] and who are the ones that urgently search for therapy. For these patients nCPAP is, at present, the treatment of choice.

The tennis ball technique is simple, inexpensive and very effective in the treatment of positional OSA patients. This therapy was well accepted by the majority of patients in the present study and most were willing to continue using it after the end of the intervention period. Several other methods have been used to train patients to avoid the supine position. Some may use a T shirt with a long vertical pocket along the back which holds three or four tennis balls. This is perhaps less likely to slip out of place during sleep. Cartwright *et al*[33] used an alarm system which wakened the patients whenever they lay on their backs. However, as noted in our study, some positional patients may not tolerate sleeping only on their side, and others may continue to sleep on their back even when a tennis ball or a baseball are used.

Some other short term studies using other types of positional devices have also shown that many patients can successfully learn to avoid the supine position during sleep.[33,38,62] However, long term compliance data using these different techniques are not yet available and studies investigating this issue are clearly needed. This is particularly the case because of the difficulties often experienced by OSA patients in compliance with current therapeutic modalities such as nCPAP,[28] weight reduction,[32] prosthetic intraoral devices,[30] and the uncertain results of surgical interventions.[31]

In summary, this study has shown that avoiding the supine position during sleep for 1 month with a simple and inexpensive method—the tennis ball technique—caused a significant reduction in 24-h BP values in hypertensive and normotensive supine-related OSA patients. Since about 30–40% of all essential hypertensive patients have OSA, and since more than half of OSA patients have far more sleep-related breathing disturbances while sleeping in the supine position than when sleeping on their side, avoiding the supine position during sleep could, if verified by larger studies, become a new non-pharmacological treatment for many hypertensive patients.

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