Sleep Position Training as Treatment for Sleep Apnea Syndrome: A Preliminary Study

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Summary: Ten male patients selected as having sleep apnea predominantly of the obstructive type associated with the supine sleep position on their evaluation night were trained for 1 additional night to avoid the back sleep position by wearing a gravity-activated position monitor/alarm on the chest. This device emitted an auditory signal if the patient remained supine for more than 15 s. The number of apneic events was significantly reduced, as were the number of episodes of significant O_2 desaturation. While wearing the alarm, the apnea index of seven patients remained within or near normal limits. On a follow-up night, with only instructions to maintain the lateral decubitus posture, five patients remained significantly improved. Sleep position training may be appropriate as a single or interim treatment for a significant number of sleep apnea patients who have position-related obstruction. **Key Words:** Apnea—Sleep position—Position training.

It has long been recognized that persons who snore do so most loudly while sleeping supine. Many home remedies and commercial devices have been employed to discourage this sleep posture. A pillow attached to the sleeper's back by a belt around the waist or a tennis ball sewn into the pajama top at the midback level are probably the two most commonly employed devices. As early as 1872 the first of many patents was issued for a mechanical device to help the snorer avoid this sleep position (1).

With the growing evidence that snoring not only disturbs the sleep of the bed partner but may also be a warning sign or early stage of obstructive sleep apnea syndrome (OSAS) (2,3), the contribution of sleep posture to the manifestation of this disorder has become recognized as more than a trivial matter (4–6). Cartwright (6) reported that, in a group of 24 unselected patients with a diagnosis of OSAS, the Apnea + Hypopnea Index (A + HI, rate of these respiratory events per hour of sleep) was twice as high during the time the patients slept in the supine position as it was during the time they slept in the lateral decubitus position. This position-associated differential in apneic rate may account, in part, for the night-to-night variability in the level of severity reported for this disorder when patients are observed in the laboratory (7). This finding of a substantial positional effect leads directly to the questions of whether it is possible to train apneic patients who have a

marked worsening of their condition while in the supine posture to avoid this sleep posture and whether this training might be a useful step in their treatment, or, for some, even a treatment in and of itself. In the original study, the degree of difference in the rate of apneic pauses per hour of sleep between the two major sleep positions was found to be closely associated with the degree of obesity. The posture-dependent difference was most marked for those who were least obese ($\leq 25\%$ above their ideal body weight) and approached equality in those most obese. Therefore, it might be expected that a treatment based on changing sleep position might be effective selectively for those who were close to ideal body weight.

METHODS

Subjects

The sample was made up of 10 male patients ranging in age from 31 to 63 years ($\bar{x}$ 48.5; SD 10.1) and in obesity from 0 to 63% above ideal body weight ($\bar{x}$ 30.6; SD 19.4). These patients were selected because they had more frequent apneic events when sleeping in the supine than in the lateral decubitus position. This was determined by monitoring each patient on closed-circuit television and recording each position change directly on the paper record. These data, in addition to the standardized polysomnographic test for this disorder (8), allowed for the separate computation of the rate of apneic and hypopneic events for time spent in each major sleep position. The criterion for diagnosis of this disorder is an Apnea Index of ≥ 5. An A + HI of < 30 may be considered to represent a mild condition and levels of an index of > 30 to be severe, as these are usually accompanied by a waking difficulty as well. On this basis there are three mild and seven severe cases in this sample.

Procedure

Each subject returned to the laboratory for a position alarm night (A), (1 to 10 months after the initial study; $\bar{x}$ 3.2 months) during which they wore a gravity-sensitive sleep position monitor/alarm (Fig. 1). This monitor/alarm was designed to record the sleep position by activating an event marker on the polygraph to differentiate side from back posture (Lloyd and Cartwright, patent pending). When the patient slept on his side a straight line was recorded, but when he moved to the back position a pulsing square wave was generated on the recording and 15 s later a buzzer in the device sounded as a signal to the patient to change sleep posture.

Some of these patients had been treated during the interval with medications such as Vivactil or with the Tongue Retaining Device (TRD). However, patients were taken off all other treatments when being recorded with the position alarm.

Following the position alarm night patients were counseled to continue to practice sleeping in the side position at home. Approximately 3 months later they were restudied for 1 night without the alarm using only the position monitor and presleep instructions (I) that they avoid sleeping on their backs. If the polysomnogram results for that night showed they were unable to do this and/or that the A + HI was not within normal limits, further training with the position alarm or other treatment was instituted.

RESULTS

Table 1 compares the all-night data for nights A and the initial evaluation night (E) on apnea index, sum of episodes of oxygen desaturation, and the lowest level of O_2 percentage recorded by the Biox II Ear Oximeter. This article reports the percentage of time spent in

FIG. 1. Patient wearing position monitor/alarm.

each sleep position on these 2 nights, along with the apnea indices associated with these postures.

The data reported in Table 1 show that the alarm was successful in increasing the time spent sleeping in the lateral decubitus position. Although few alarm signals occurred (0–5, x̄ 1.2), the percentage of side sleep time for the group was doubled (from 48.6 to 97.9%) and the percentage of time supine significantly decreased for all 10 subjects, with only patient 6 spending any appreciable time on his back (58 min, 18%). This patient snored

TABLE 1. *Comparison of sleep apnea parameters on evaluation (E) and position alarm (A) nights*

Patient	All-night A + HI		ΣO₂ desaturation		Lowest O₂		Side sleep time %		A + HI		Back sleep time %		A + HI	
	E	A	E	A	E	A	E	A	E	A	E	A	E	A
1	5	1	95	4	83	97	77	100	9	4	23	0	27	0
2	50	0	188	1	60ᵃ	93	58	100	31	0	42	0	76	0
3	82	7	354	22	60	80	0	100	0	3	100	0	82	0
4	23	10	113	42	78	72	92	97	16	8	8	3	57	51
5	126	69	588	329	65	66	0	100	0	69	100	0	126	0
6	54	82	281	378	77	82	58	82	37	86	42	18	79	63
7	55	1	170	2	85	87	91	100	48	1	9	0	91	0
8	61	0	360	3	63	94	35	100	51	1	65	0	66	0
9	9	0	1	0	90	97	75	100	1	0	25	0	34	0
10	82	44	442	—ᵇ	75	—	0	100	0	44	100	0	82	0
x̄	54.7	21.4	238.8	86.7	73.4	85.3	48.6	97.9	19.3	21.6	51.4	2.1	72.0	11.0
SD	36.8	31.6	177.0	152.3	11.6	11.2	37.5	5.7	20.7	32.3	37.5	5.7	28.4	24.2
t	3.26		3.02		2.61		4.02		.16		4.09		5.01	
p	<.01		<.02		<.05		<.01		NS		<.01		<.01	

A + HI, Apnea + Hypopnea Index.
ᵃOximeter not accurate below 60%. All readings below 60% recorded as 60%.
ᵇOximeter malfunctioned that night.

so loudly he did not discriminate the sound of the buzzer from his snoring until a volume adjustment was made on the device.

The group as a whole had a significant decrease in all-night A + HI from 54 to 21 ($t = 3.26$, $p < 0.01$), with 7 of the 10 patients having dramatic reductions in their A + HI while wearing the alarm device. With no other treatment these seven were at or near normal values on that night.

There was also a significant reduction in the number of desaturation episodes on the alarm night from 238 to 86 ($t = 3.02$, $p < 0.02$) and an increase in the lowest level of O₂ saturation reached from a mean low of 73 to 85% ($t = 2.61$, $p < 0.05$).

Table 2 compares the number of apneic events by type on the E and A nights, showing a consistent drop in the obstructive events, except for patients 6 and 10. This raised the question of whether these positive results could be attributed to factors other than position, such as changes in weight or sleep architecture. Table 3 displays the sleep stage percents on the E and A nights showing no appreciable differences between the two. Table 4 gives the weight for these patients on all 3 nights, eliminating weight loss as accounting for these findings.

The 3-month follow-up data (Table 5) show that the group as a whole was still significantly improved on the all-night A + HI (x̄ 32.8) and slept approximately one-half the time in the supine position as they had originally. However, only four patients were able to maintain the side sleep posture during the whole of their laboratory reassessment night without the reinforcement of the alarm. No home monitoring has been done as yet to determine whether laboratory position training is generalized to the home setting or if it is specific to the laboratory setting. The general pattern is for some regression to have taken place over the follow-up period when no reinforcement was provided.

TABLE 2. *Apneic and hypopneic events by type on evaluation (E) and position alarm (A) nights*

Patient	Night	Obstructive	Central	Mixed	Hypopneas	Total
1	E	20	3	0	13	36
	A	1	0	0	3	4
2	E	247	2	5	10	264
	A	0	0	0	1	1
3	E	361	17	42	18	438
	A	24	1	2	14	41
4	E	83	11	0	34	128
	A	45	1	0	8	54
5	E	464	2	10	132	608
	A	287	5	48	122	462
6	E	241	12	13	53	319
	A	413	1	17	17	448
7	E	214	14	6	17	251
	A	5	1	0	2	8
8	E	235	18	84	23	360
	A	0	0	0	3	3
9	E	53	0	0	0	53
	A	0	0	0	0	0
10	E	42	11	401	4	458
	A	156	9	35	0	200

The pattern of change in severity level of the patients on the 3 recording nights, E, A, I, is displayed in Fig. 2.

Not all patients showed sufficient improvement with position change alone to continue untreated. The three who were still severely affected (patients 5, 6, and 10) were all obese. Patient 5 was fitted with a Tongue Retaining Device (TRD) (9), which in conjunction with side sleeping has brought him to a level of complete control (A + HI, 1/h). Patients 6 and 10 both failed to improve with a TRD and have had subsequent surgical treatment (uvu-

TABLE 3. *Comparison of sleep stages evaluation (E) and position alarm (A) nights and number of alarm signals given*

Patient	Sleep stage E (%)					Sleep stage A (%)					Number of signals
	1	2	3	4	REM	1	2	3	4	REM	
1	9	53	16	1	21	9	53	6	5	17	1
2	44	34	13	0	9	14	67	12	1	7	1
3	49	44	0	0	6	26	53	0	0	21	0
4	17	63	0	0	20	7	78	0	0	15	1
5	77	1	0	0	22	61	19	0	0	20	1
6	27	51	0	0	22	53	34	0	0	13	2
7	56	33	0	0	11	13	68	7	0	11	0
8	14	70	1	0	15	7	81	0	0	12	1
9	24	61	0	0	15	10	73	0	0	17	5
10	50	35	0	0	15	64	19	0	0	17	0
x̄	36.7	44.5	3.0	.1	15.6	26.4	54.5	2.5	.6	16.0	1.2
SD	21.8	20.0	6.1	.3	5.6	23.5	23.3	4.3	1.6	5.7	1.5

TABLE 4. *Patients' weight (kg) on evaluation (E), position alarm (A), and presleep instruction (I) nights*

Patient	E	A	I
1	103.0	103.0	100.4
2	82.8	77.8	76.5
3	92.7	94.1	95.4
4	81.5	79.2	89.1
5	106.7	109.4	109.8
6	117.5	117.0	120.6
7	80.6	82.4	82.4
8	86.4	80.1	80.1
9	78.8	76.1	76.1
10	99.9	97.7	95.4
x̄	93.0	91.7	92.6
SD	13.2	14.7	14.8

lopalatopharyngoplasty), also without benefit. Both have also been unable to sustain weight reduction.

DISCUSSION

At this time the feasibility of using a position alarm to reduce time in the supine position, and so to reduce the number and severity of the respiratory events, has been established only in the laboratory setting with the aid of the position alarm. The next step in this work is clearly to discover if this training generalizes to the home setting and if it can be maintained there without further reinforcement with the alarm. It is possible that some patients may learn to avoid the back sleep posture and not need the alarm at all, just as we have all learned not to fall out of bed by monitoring where the edge is during sleep. However, others may need the buzzer to reinforce this training either periodically or consistently.

TABLE 5. *Night 3 follow-up without alarm: presleep instructions to side sleep only*

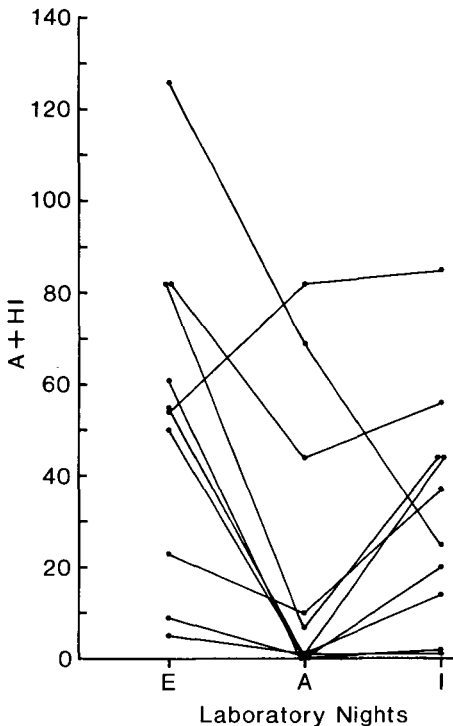| Patient	All-night A + HI	O₂	Lowest ΣO₂	Side sleep time %	A + HI	Back sleep time %	A + HI
1	1	0	97	100	1	0	0
2	20	112	79	83	15	17	46
3	44	106	76	67	20	33	93
4	37	179	80	91	25	9	82
5	25	144	72	99	25	1	0
6	85	422	84	68	81	32	93
7	14	70	88	100	14	0	0
8	44	284	78	0	0	100	44
9	2	11	88	51	0	49	3
10	56	242	76	100	56	0	0
x̄	32.8	157.0	81.8	75.9	23.7	24.1	36.1
SD	25.9	130.1	7.5	31.8	26.1	31.8	40.8

A + HI, Apnea + Hypopnea Index.

FIG. 2. Apnea + Hypopnea Index (A + HI) on laboratory evaluation (E), position alarm (A), and presleep instructions (I) nights.

Home recording with ambulatory monitors will help to answer this question empirically. It is encouraging that in the laboratory so few signals were needed to control sleep posture.

Another problem requiring investigation is whether those obese patients who did not initially show a position-dependent severity differential will develop this following a weight loss. If this should be established it might be used to motivate some patients who have previously had difficulty losing weight. In the present sample patient 8 showed no position difference until he lost a modest amount of weight (14 lbs, 206 down to 192 lbs).

This study also suggests another factor which needs addressing, i.e., whether the severity of OSAS is being overestimated in the laboratory where patients often feel constrained by the monitors, especially the ear oximeter, to sleep in the supine position. Patients sometimes report in the morning that they spent more time in this position during their laboratory evaluation than they typically do at home. Sleep disorders centers need to recognize the contribution of body position to their estimation of sleep apnea severity and therefore instruct patients to occupy their usual sleep postures if possible.

Training to avoid the supine position appears to have promise as a noninvasive treatment either as a single therapy or in combination with others such as weight loss and TRD. In this preliminary study even patients with quite severe obstructive sleep apnea have shown a good response to this simple approach. Noninvasive treatments need to be considered and tested prior to the more invasive approaches for the control of this disorder.

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