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Effect of Sleep Position on Sleep Apnea Severity

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Summary: Thirty male patients evaluated sequentially for sleep apnea syndrome by all-night clinical polysomnography were compared for apnea plus hypopnea index (A + HI) during the time in the side versus time in the back sleep posture. For 24 subjects of this sample, who occupied both major body positions during the evaluation night, the apnea index was found to be twice as high during the time spent sleeping on their backs as it was when they slept in the side position. This difference is reliable and inversely related to obesity. Five patients meeting diagnostic criteria for sleep apnea on an all-night basis fell within normal limits while in the side sleep position. This suggests sleep position adjustment may be a viable treatment for some nonobese sleep apnea patients. **Key Words:** Sleep position—Apnea—Weight.

Recently the question of a relationship between sleep posture and sleep quality has been given substantial support in a study by DeKoninck et al. (1). Using criteria developed by Monroe (2) to select subjectively defined good and poor sleepers, they found poor sleepers to differ markedly from good sleepers in the amount of time they spent sleeping on their backs with their heads straight. In an earlier study Harper and Sauerland (3) reported that when sleep apnea patients sleep in the supine position there is a tendency for the tongue to relapse against the pharyngeal wall and, further, that during REM sleep, with the additional factor of reduced tone in the genioglossus muscle, apneas are more frequent and prolonged than when patients sleep in a semiprone position.

Patient and bed partner reports as well as some pilot work (4) support the implication that the supine position is the one in which many sleep apnea patients snore the loudest and have their most disturbed respiratory patterns. Many patients with severe sleep apnea of the obstructive type adopt strange sleep positions to avoid the back sleep posture. Sleeping upright in a chair or even kneeling beside the bed has been observed. This suggests a pilot investigation of sleep apneic events in relation to sleep position might provide useful information with respect to treatment choice.

METHODS

Subjects

Thirty sequential male patients who met the diagnostic criteria for sleep apnea syndrome by having more than 30 apneic events in a full night of recorded sleep (five or more events

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per hour) with these being predominantly of the obstructive type, formed the sample for this study. All patients being evaluated were weighed prior to their polysomnogram. Patients were monitored for the usual eight channels of information: R/L electro-oculogram (EOG), C_3/A_2, chin electromyogram (EMG), SO_2, N/O air flow, chest and abdominal impedance, and electrocardiogram (EKG). All patients were also monitored by closed-circuit TV. Sleep technicians recorded each change in sleep position directly on the polygraph record, noting the body position as back, side, or stomach, with head straight or turned to the left or right side.

Data analysis

All apneic and hypopneic episodes were scored by traditional criteria (5) and the number of obstructive, central, and mixed apneas, and the number of hypopneic events per hour of sleep was first obtained for total sleep time (A + HI). Then this index was calculated for time in the back and side positions separately. Only three patients in the sample spent any time in the prone position. This was probably due to the restrictions on free movement imposed by the ear oximeter. Therefore, the prone position data were eliminated from this analysis. Also, since there were only a few episodes in which the body and head were recorded as discordant for position the data analysis was based on body position only. Six patients who did not vary from one sleep position throughout the night were also excluded from the data analysis. These patients did not differ from the remaining 24 subjects on any major variable: height, weight, obesity, or severity.

It was predicted that the apnea plus hypopnea index (A + HI) would be lower while patients were sleeping on their sides than while they were sleeping in the back position and that this would be a reliable difference. It was also predicted that this differential advantage of the side position would be reduced with increasing obesity. Therefore, the data were analyzed to test three predictions: (a) that within subjects the A + HI will be significantly lower during the time in the side than in the back sleep position, (b) that this difference would be a reliable individual difference without treatment, and (c) that the advantage of side sleeping would be reduced as degree of obesity increased.

RESULTS

Table 1 gives the basic data for this sample: weight in kilograms, height in centimeters, number of actual kilograms above the ideal weight (using the formula 106 lbs + 6 lbs for each inch above 5 ft converted to kilograms, (A − I), the obesity percentage [(A − I/A) × 100], severity on an all-night basis as measured by the A + HI, the A + HI calculated separately for time in the back and side positions (BI and SI), and the differential advantage of the side over the back position calculated as a ratio, SI/BI. A matched group t test was computed for the significance of the difference between the mean BI and the mean SI. This difference is significant beyond the 0.01 level ($t = 5.75$; df 23). This suggests support for the first prediction, that male obstructive sleep apnea patients, selected only to vary their sleep posture during the night, will have more respiratory events per hour of sleep when sleeping in the supine than in the side position.

Seven of the patients in this sample have had a second laboratory evaluation approximately 1 month later under the same conditions as those of the original sleep test. None of these patients had had surgery; there were none with significant changes in weight; those patients who were being treated for their apnea with medication were off medication for this evaluation; and those treated with the Tongue Retaining Device (TRD) (6) were not wearing it during this night. The percentage of total sleep time spent in the back sleep position

TABLE 1. *Basic data for 24 male obstructive sleep apnea patients with varied sleep position*

Patient number	Weight (kg)	Height (cm)	A − I (kg)[a]	Percentage obesity	A + HI	BI	SI	SI/BI
1	113.6	185.4	30.0	26.4	112	102	120	1.17
2	83.2	182.9	2.3	2.7	65	71	18	0.25
3	100.9	182.9	20.0	19.8	53	88	28	0.31
4	87.7	177.8	12.3	14.0	55	91	48	0.52
5	168.2	182.0	87.3	51.9	115	158	103	0.65
6	78.6	180.3	0.5	0.6	8	36	1	0.02
7	90.9	180.3	8.2	9.0	12	21	5	0.23
8	80.5	167.6	15.9	19.8	5	6	0	0.00
9	118.2	188.0	31.8	26.9	52	68	27	0.39
10	80.5	190.5	−8.6	−10.0	11	15	9	0.60
11	107.7	167.6	43.2	40.1	82	88	71	0.80
12	147.3	182.9	66.4	48.1	111	121	100	0.82
13	131.8	185.4	48.2	36.6	55	60	50	0.83
14	82.3	180.3	4.1	5.0	23	57	16	0.28
15	89.1	182.9	8.2	9.2	51	94	73	0.78
16	88.6	188.0	2.3	2.6	27	39	12	0.30
17	129.1	182.9	48.2	37.3	79	80	79	0.98
18	139.1	167.6	74.5	53.6	82	85	79	0.92
19	127.3	180.3	49.1	38.6	54	79	37	0.46
20	90.5	180.3	12.3	13.6	8	10	8	0.80
21	82.7	182.9	1.8	2.2	38	58	14	0.24
22	71.4	172.7	1.8	2.5	10	12	0	0.00
23	73.2	172.7	2.7	3.7	25	74	10	0.13
24	77.3	180.3	−0.9	−1.2	7	10	0	0.00
$\bar{X}$	101.6	180.2	23.4	18.87	47.5	63.5	37.8	0.48
SD	26.6	6.3	26.7	18.74	35.4	39.0	37.5	0.35

[a]A − I, actual minus ideal weight.

differed between these two occasions, but the positional score (SI/BI ratio) proved to be highly reliable ($r = +0.87$) (Table 2). This finding appears to confirm the second prediction, that without treatment the ratio of number of apneic events per hour of sleep on side versus back is a stable index.

The question of whether this ratio is sleep-stage dependent was not addressed in this pilot study, nor were other parameters such as SO_2 level or length of apneic events analyzed by sleep position. These will be calculated separately for the time in each sleep position on all subsequent patients. However, the stability of the positional ratio score within a small group of subjects between two occasions when the amount of sleep time in each position varied considerably suggests that the differential position effect may be independent of sleep stage.

Since it is generally believed that the severity of sleep apnea and obesity are related, the overall correlation of these two variables was computed for this sample prior to testing the third prediction: that the positional difference in apnea index will be reduced in the more obese.

The Pearson product moment correlation between the obesity percent (difference in kilograms between actual and ideal weight, [(A − I/A) × 100] and the overall severity score (A + HI) was +0.78. The r between the obesity percentage and the SI is 0.77, but the correlation of obesity and BI is somewhat lower at 0.67. A partial correlation to take out the contribution of obesity to the correlation of sleep apnea severity in the two major sleep

TABLE 2. *Reliability of positional apnea index for seven patients on two occasions*

Patient number	1 A + HI	2 A + HI	1 Time (%) back	2 Time (%) back	1 SI/BI	2 SI/BI
2	65	57	90	53	0.25	0.21
5	115	95	22	69	0.65	1.11
14	23	37	15	16	0.28	0.31
19	54	82	42	17	0.46	1.37
22	10	15	85	62	0.00	0.04
23	25	37	5	31	0.13	0.45
24	7	12	64	91	0.00	0.00
$\bar{X}$	42.7	47.9	46.1	48.4	0.25	0.50
SD	38.5	31.8	34.2	28.2	0.24	0.53
	$r = 0.92$ $p < 0.01$		$r = 0.49$ NS		$r = 0.87$ $p < 0.01$	

NS, not significant.

positions resulted in a reduction of this value to a nonsignificant level. The correlation of BI and SI (0.84) with obesity percentage partialed out equals 0.32. When obesity is controlled for, there is no longer a significant relation between the BI and SI.

Taking as a cut-off point a difference of 50% or more in apnea index between back and side sleep positions (0.50 ratio score), we found that 14 of the 24 subjects met this criterion. Of these, 12 would be classed as nonobese on the basis of being less than 25% above their ideal weight. Seven of the remaining ten who had less than a 50% differential between back and side index met the obesity criterion. In other words, 86% of those close to normal weight and only 14% of the obese breathe more regularly when sleeping in the side than in the back position. This may be a useful rule of thumb: patients who are within 25% of their ideal weight are likely to be significantly improved in terms of number of apneic events by sleeping in the side body position (Fig. 1).

In fact, using an A + HI of 30 events per hour as a division between a mild and a moderate to severe number of sleep apneic events, eight patients, who would be classified as severe on the basis of their Back Index, would be classed as mild on the basis of their index in

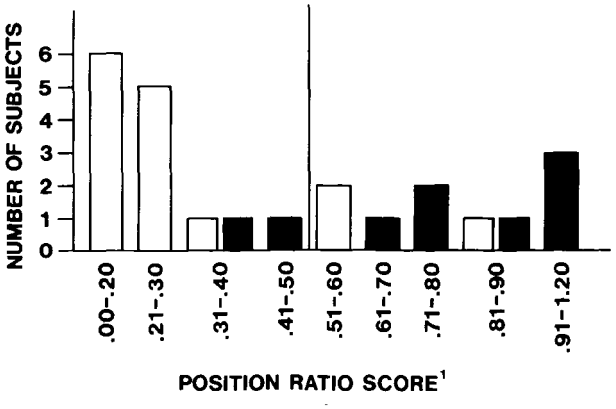

FIG. 1. The inverse relation of positional apnea index (SI/BI) and obesity. Less than 25% over ideal weight, □; more than 25% over ideal weight, ■. [1]Ratio: >1.00, Side I higher than Back I; <1.00, Side I lower than Back I.

the side position (patient nos. 2, 3, 6, 9, 14, 16, 21, 23). Also, five patients who would be classed as mild on the basis of the all-night A + HI (nos. 6, 7, 8, 22, 24) would be within normal limits if they occupied only the side sleep position.

DISCUSSION

These preliminary findings suggest that, in general, male sleep apnea patients of the obstructive type show a worsening of their respiratory difficulty when they sleep on their backs. Although the number of respiratory events per hour is highly correlated with obesity, the increase in severity in the back position relative to the side is most striking in those close to normal weight. This would appear to implicate a worsening of an airway obstruction due to an event specific to the back sleep posture. It is likely that Harper and Sauerland (3) are right in suggesting that in this position gravity allows the tongue to fall backward against the pharyngeal wall. This may add to the predictability of response to some treatments such as the TRD (6), designed to prevent the relapse of the tongue in sleep. These findings may also aid in the selection of patients for another noninvasive treatment, a device to train patients to sleep only in the side position. Such a device (Sleep Posture Monitor and Alarm, developed by Lloyd and Cartwright, patent pending) is currently being tested in this laboratory.

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