

The Effects of Sleep Posture and Sleep Stage on Apnea Frequency

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Summary: The Apnea Plus Hypopnea Index (A+HI) of 60 male positional sleep apneics was analyzed by sleep stage to determine if positional differences are limited to NREM sleep. Differences in apnea severity by sleep position were found to persist in REM sleep and to be of equal extent to those differences found in NREM sleep, despite the fact that there is also a significant increase in the frequency of apneic events associated with REM sleep. The positional effect persists in REM sleep, making treatments to control sleep posture a viable option. **Key Words:** Sleep position—Apnea.

Recently (1) it was pointed out that studies indicating the effect of sleep position on sleep apnea severity have failed to take sleep stage into account (2-8). From their study of seven obese apneic patients, George et al. (1) confirmed that apneas and hypopneas occurred more frequently when their patients slept in the supine position, but only when they were in NREM sleep. During REM sleep they reported that the Apnea Plus Hypopnea Index (A+HI) did not differ by position. They concluded that REM sleep has a more powerful effect on the severity of sleep-related respiratory events than does sleep position. It should be added that these authors noted that their findings may have been biased by the fact that their patients were all obese and well above the cutoff of 125% of ideal body weight reported by Cartwright et al. (7) as characteristic of those showing a strong positional difference in apnea severity (i.e. an A+HI supine of two or more times the rate during lateral sleep).

In light of the George et al. (1) finding of no difference by sleep position in REM for a small sample of obese patients, it seemed important to look into the effect of sleep stage on the frequency of apneic and hypopneic events in a larger sample of patients who initially meet the "positional" differential in frequency. The purpose is to determine whether the positional difference is limited to NREM sleep in such patients. If so, this

might call into question the usefulness of retraining the sleep posture as a major treatment of the positional patient.

SAMPLE

The sample was made up of 60 male patients newly identified as meeting a two-fold criterion: (a) having an all-night A+HI equal to or greater than 12.5 and (b) having an A+HI during supine sleep of two or more times the rate during sleep in the lateral position. Table 1 describes the patient sample.

METHOD

All patients were recorded throughout the night by clinical polysomnography using a minimum of 12 channels of information, according to the standard protocol for sleep apnea evaluation outlined by Bornstein (9). In addition, sleep position was continuously recorded on the paper record via a monitor developed by Lloyd (7). This was verified visually by the technologist through the use of a low-light camera positioned opposite the patient's bed, with the image viewed on a TV monitor in the control room. All records were scored for sleep stage by the Rechtschaffen and Kales manual of rules (10) and for apneic and hypopneic events by the Guilleminault (11) criteria.

RESULTS

Only 24 of the 60 patients slept on both back and side in both REM and NREM sleep stages. Twenty-

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TABLE 1. *Sample description of positional sleep apneic patients*

Patient number	Age (yr)	Height (in)	Weight (kg)	Body-weight factor (ideal = 1.00)
1	43	70.0	102.2	1.36
2	35	70.0	172.9	2.29
3	42	71.5	92.7	1.17
4	43	71.0	96.6	1.24
5	65	67.0	100.7	1.50
6	58	72.0	95.4	1.18
7	45	72.0	103.9	1.28
8	56	67.0	79.8	1.19
9	31	69.0	90.9	1.25
10	44	66.0	79.5	1.23
11	42	65.2	75.5	1.21
12	55	66.7	105.0	1.58
13	47	71.5	96.4	1.21
14	30	69.0	130.0	1.79
15	46	70.5	82.0	1.00
16	51	68.0	101.6	1.44
17	47	70.0	84.8	1.12
18	52	66.2	68.3	1.05
19	63	67.0	96.8	1.44
20	51	66.0	114.5	1.77
21	48	69.0	102.2	1.41
22	57	68.2	87.3	1.24
23	57	64.0	72.2	1.07
24	67	68.5	97.3	1.37
Mean	48.96	68.55	97.02	1.35
SD	9.77	2.28	21.25	0.29

two had no REM sleep while in the supine position, four had no REM in the lateral position, nine had no NREM in the lateral position and one had no NREM time during supine sleep. All data analyses are based on the reduced sample size of 24 (see Table 2).

Table 2 shows the mean number of minutes these 24 patients slept in each position and sleep stage combination. Subjects spent approximately equal NREM sleep time on the side and back, but when in REM, as a group they spent only half as much time on the back as in the side sleep position. The *t* test for matched groups between the two means, side 36.73 and back 18.33, is significant at $p < 0.01$ ($t = 3.46$, 23 df). This confirms the first impression, gained from finding that a large proportion of subjects had no REM sleep while supine, that this position is not well tolerated by the positional patient during REM sleep.

A one-way repeated-measures ANOVA was performed across the four conditions—NREM side, REM side, NREM back and REM back—using a multivariate test [$\Lambda = 0.25705$, $F(3,21) = 20.2084$, $p < 0.001$]. Following this, a post-hoc analysis was performed using the Newman-Keuls test for repeated measures. The results show that all pairwise differences were larger than critical values at $p < 0.01$. In other words, both stage and position effects were significant.

Table 3 highlights the differences in A+HI reported in Table 2. The difference in rate by position is large, but equally so in REM and in NREM sleep. Looking

TABLE 2. *Time (in minutes) and A+HI in REM and NREM sleep by patients in lateral and supine positions*

Patient number	Time				A+HI			
	Side NREM	Back NREM	Side REM	Back REM	Side NREM	Back NREM	Side REM	Back REM
1	86.0	208.0	14.0	22.0	8.4	102.1	38.6	95.5
2	185.5	95.5	34.0	18.0	2.3	21.0	44.1	60.0
3	73.5	173.0	18.5	27.0	2.4	89.1	90.8	102.2
4	76.0	146.5	73.0	34.5	7.9	24.2	3.3	60.9
5	236.0	27.0	68.0	37.5	16.3	35.6	28.2	43.2
6	81.5	213.0	23.0	36.5	8.1	42.5	2.6	60.8
7	229.0	53.5	6.5	10.5	9.4	95.3	46.2	142.9
8	176.5	103.0	21.0	19.5	35.0	75.7	37.1	46.2
9	211.5	122.5	35.5	34.5	0.9	17.6	47.3	62.6
10	152.5	76.5	35.0	1.5	5.9	51.8	15.4	40.0
11	151.5	201.5	26.5	26.5	4.8	16.4	11.3	67.9
12	174.5	105.5	52.5	25.5	2.8	20.5	35.4	80.0
13	188.5	109.0	83.5	5.0	10.8	57.2	18.7	300.0
14	119.5	100.5	84.0	7.0	71.3	103.3	7.9	111.4
15	157.0	168.5	39.5	13.0	0.4	34.5	9.1	9.2
16	291.0	25.5	51.5	5.0	4.5	56.5	45.4	84.0
17	231.5	63.0	42.5	5.0	19.5	75.2	35.3	24.0
18	148.5	117.0	39.5	16.5	12.9	71.3	9.1	61.8
19	159.5	32.5	27.5	11.5	29.0	190.2	76.4	114.8
20	107.5	265.5	16.5	1.5	7.8	27.6	18.2	40.0
21	150.0	118.0	23.5	21.0	10.0	69.7	30.6	102.9
22	196.5	71.5	25.0	45.5	4.9	35.2	2.4	60.7
23	34.0	214.0	7.0	13.5	12.4	64.2	68.6	66.7
24	206.0	107.5	34.0	2.0	67.0	93.2	37.1	90.0
Mean	159.29	121.58	36.73	18.33	12.27	61.25	31.63	80.32
SD	61.75	65.20	22.11	12.91	15.09	39.49	23.71	56.04

TABLE 3. Differences in A+HI by sleep stage and sleep position

	Side	Back	Difference, back - side
NREM	12.27	61.25	48.98
REM	31.63	80.32	48.69
Difference, REM - NREM	19.36	19.07	

at the other dimension, the difference in A+HI between the REM and NREM stages in the lateral position is more modest but equal to the difference between the rate in these two stages during supine sleep time.

DISCUSSION

Patients whose all-night A+HI is twice as high in the supine as in the lateral sleep posture also show the usual elevation of these events during REM sleep over their NREM rate. However, position appears to be the more serious factor for them, as the supine A+HI is elevated equally in both sleep stages over the lateral rate. This appears to be due, at least in part, to the anatomical differences in the positional patients revealed by cephalometric X rays (12). Given that these patients show a larger posterior airway space, less elongated soft palate, and somewhat more prominent retrognathia than unselected sleep apnea patients, they are more likely to occlude the airway in supine sleep with retrolapse of the flaccid tongue.

When positional apnea patients exhibit an A+HI in the lateral position that is within or close to normal limits, treatment consisting of training them to avoid the supine sleep position has a high likelihood of suc-

cess. Positional apnea patients exhibiting lateral A+HIs in the moderate range may benefit from sleep position training combined with other treatments.

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