

SCIENTIFIC INVESTIGATIONS

## Poor Long-Term Patient Compliance with the Tennis Ball Technique for Treating Positional Obstructive Sleep Apnea

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**Study Objectives:** Little is known regarding long-term patient compliance with the tennis ball technique (TBT), one of the original simple methods of positional therapy (i.e., avoiding the supine posture during sleep) for posture-dependent obstructive sleep apnea patients. The purpose of this study was to investigate long-term patient compliance with TBT.

**Methods:** A follow-up questionnaire was mailed to all patients prescribed TBT at the Adelaide Institute for Sleep Health between July 2004 and March 2008 ( $n = 108$ ).

**Results:** Sixty-seven patients replied to the questionnaire. Baseline demographic/clinical characteristics were not significantly different from non-respondents. Among the respondents, follow-up time was (mean  $\pm$  SD)  $2.5 \pm 1.0$  years. Four (6.0%) reported they were still using TBT (group A); 9 (13.4%) were no longer using TBT, claiming to have learned to avoid the supine position during sleep (group B); and

54 (80.6%) were neither using TBT nor avoiding the supine posture (group C). The main reason for ceasing TBT use in group C was that TBT was too uncomfortable (34/54 patients).

**Conclusions:** Long-term patient compliance with TBT appears to be very poor, with less than 10% of patients reporting continued use (group A) ~30 months after prescription. With most TBT non-compliers reporting it to be too uncomfortable, alternative forms of positional therapy appear to be needed.

**Keywords:** Obstructive sleep apnea, tennis ball technique, positional therapy, body posture

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The deleterious effect of the supine sleep posture on obstructive sleep apnea (OSA) has long been recognized. In OSA patients, the supine sleep posture is associated with an increase in upper airway collapsibility<sup>1</sup> and thus an increase in the frequency of sleep-related breathing abnormalities<sup>2</sup> as measured by the apnea-hypopnea index (AHI). Positional OSA is said to be present when a patient has an AHI in the supine position at least twice that in the lateral position, meaning that the patient's breathing abnormalities occur predominantly while sleeping supine. Numerous positional therapy strategies have been developed to prevent such patients from sleeping on their backs, but the tennis ball technique (TBT) is probably the oldest and simplest.<sup>3,4</sup> This therapy comprises a tennis ball fastened to the back with a belt/strap, discouraging the patient from sleeping supine.

Oksenberg et al.,<sup>5</sup> in one of the few TBT efficacy studies, tested TBT in 12 positional OSA patients. TBT reduced mean ( $\pm$  SD)

supine sleep time from  $79.0\% \pm 28.1\%$  to  $12.3\% \pm 19.7\%$  ( $p < 0.001$ ) and correspondingly the overall AHI from  $46.5 \pm 19.9$  to  $17.5 \pm 19.4$  events/h ( $p < 0.002$ ). In the same study, TBT compliance was assessed in 50 positional patients via a mail survey. At 6-month follow-up, 19 (38%) were still using TBT (group A); 12 (24%) were no longer using TBT, as they claimed to have learned to avoid the supine posture (group B); and 19 (38%) were not using TBT but had not learned to avoid the supine posture (group C). In effect, groups A and B could be considered as treatment "successes" and group C as treatment "failures," although without evidence that patients can successfully learn to avoid supine sleep, group B may also represent "failures." Besides this study by Oksenberg et al.,<sup>5</sup> nothing is known regarding long-term patient compliance with TBT, or indeed with any form of positional therapy.

The aim of this study was to investigate, via a questionnaire, long-term compliance with TBT among positional OSA patients issued with a TBT device from our laboratory.

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## METHODS

### Subjects

Potential participants were 108 positional OSA patients (overall AHI:  $32.4 \pm 35.2$ ; supine AHI:  $53.9 \pm 22.4$ ; lateral AHI:

**Table 1**—Baseline Characteristics of Subsequent Questionnaire Respondents and Non-Respondents

	Respondents ( <i>n</i> = 67)	Non-respondents ( <i>n</i> = 41)	<i>p</i> value
Gender, M/F	58/9	36/5	0.85
Age, yr	59.6 ± 12.1	53.8 ± 18.1	0.05
BMI, kg/m <sup>2</sup>	28.7 ± 4.2	29.3 ± 8.5	0.45
Overall AHI, events/h	29.6 ± 13.6	36.8 ± 45.6	0.41
Supine AHI, events/h	53.0 ± 20.3*	55.2 ± 24.6*	0.64
Lateral AHI, events/h	14.1 ± 9.9	13.9 ± 13.6	0.91

Data expressed as number or mean ± SD. BMI refers to body mass index; AHI, apnea-hypopnea index. \**p* < 0.05 compared to lateral AHI.



**Figure 1**—Tennis ball technique for the treatment of supine-dependent obstructive sleep apnea.

14.0 ± 11.3 events/h) prescribed and issued with TBT at the Adelaide Institute for Sleep Health, Repatriation General Hospital, between July 2004 and March 2008 for whom postal addresses were available and for whom no death was recorded in the hospital record. AHI from each patient's original baseline study was based on nasal pressure based airflow, thoracoabdominal effort, and SpO<sub>2</sub> signals scored according to AASM criteria,<sup>6</sup> with AHI ≥ 15 and < 30 considered mild, ≥ 30 and < 45 moderate, and ≥ 45 severe OSA.

### Tennis Ball Technique

We used a validated TBT device (Figure 1) previously shown to reduce mean (± SD) supine sleep time from 42.5% ± 26.8% to 7.9% ± 13.9% and AHI from 22.1 ± 14.9 to 7.3 ± 5.5 events/h.<sup>7</sup> Each TBT device was manufactured by hospital volunteers according to the original pattern,<sup>7</sup> with some patients making a voluntary monetary contribution towards the production of the accompanying strap (usually AU\$20) and the laboratory covering remaining material costs. All patients received information and training regarding the use of TBT at the time of issue.

### Protocol

Following approval from the Repatriation General Hospital Research and Ethics Committee, a questionnaire (see Appendix) was mailed to all identified potential participants. Two mail-outs of the questionnaire with postage-paid reply envelopes were sent, the first to all eligible patients (July 2008) and the second to all initial non-respondents (December 2008). In an attempt to maximize responses, the second mail-out also included stamped (rather than franked) envelopes and handwritten addresses (instead of printed stickers).<sup>8</sup>

Respondents were divided into 3 mutually exclusive groups using criteria described by Oksenberg et al.<sup>5</sup>: group A (still

using TBT), group B (no longer using TBT, claiming to have learned to avoid supine sleep), and group C (no longer using TBT and not claiming to have learned to avoid supine sleep). The main reason(s) why patients in group C ceased using TBT were also investigated (see Appendix).

### Statistical Analysis

To examine potential response bias gender, age, body mass index (BMI), and AHI (overall, supine, and lateral AHIs) were compared between respondents and non-respondents using  $\chi^2$  test (gender) and independent samples Student *t*-tests. Supine-dependence of OSA was established in respondents and non-respondents via paired Student *t*-tests with Bonferroni adjustment for 2 comparisons. Data are expressed as means ± SD or number (%). *P* values < 0.05 were considered statistically significant.

## RESULTS

Two mail-outs of the questionnaire yielded a total of 67 respondents (49 and 18 from the initial and second mail-out, respectively) and 41 non-respondents. Other than age, for which there was a borderline significant difference between respondents and non-respondents, there were no significant differences between groups (Table 1). Among the 67 respondents, average follow-up time was 2.5 ± 1.0 years. There were 4 (6.0%), 9 (13.4%), and 54 (80.6%) patients in groups A, B, and C, respectively.

The reason(s) why patients in group C (*n* = 54) stopped using TBT were as follows (many patients cited more than one reason): 34 (63%) reported that TBT was too uncomfortable; 18 (33%) responded that the tennis ball moved around; 14 (26%) found no improvement in sleep quality or daytime alertness; 13 (24%) claimed that TBT did not prevent them from sleeping supine (i.e., ineffective); and 7 (13%) reported that TBT caused backache. A further 7 "Other" reasons were volunteered: patient claimed not to sleep on his/her back (*n* = 3), shoulder problems (*n* = 1), skin irritation from using TBT (*n* = 1), ineffectiveness when using a soft mattress (*n* = 1), and suspicion that TBT would cause back problems (*n* = 1).

## DISCUSSION

The tennis ball technique is one of the first described therapies for preventing supine sleep in positional OSA patients.<sup>3</sup> However, few data exist concerning long-term patient compliance with this treatment. The present study suggests that after an average follow-up period of ~30 months, very few (< 10%)

patients prescribed TBT report continuing use, with the majority (~81%) neither using TBT nor avoiding the supine posture (group C), rendering them treatment failures. Furthermore, with no verification of supine sleep avoidance without treatment in the 9 group B patients, the proportion of treatment failures could be in the order of 90%. While 38% (41/108) of patients did not respond to the questionnaire, there were no significant differences in terms of age, gender, BMI, or AHI values between respondents and non-respondents, suggesting that systematic bias in at least these variables would be unlikely to impact the main findings. Given that patients who do not respond to follow-up surveys tend to exhibit poorer treatment outcomes than respondents,<sup>9,10</sup> overall treatment compliance in all 108 patients prescribed TBT from our laboratory is likely to be very poor regardless of the potential for response bias.

The main reason for patients stopping TBT treatment in group C was that TBT was too uncomfortable (34/54 patients). This finding is consistent with the results of Oksenberg et al.,<sup>5</sup> who reported that 10 of their 19 group C patients found TBT excessively uncomfortable. Therefore, despite its efficacy in reducing supine sleep time and hence AHI,<sup>5,7</sup> the fact that TBT is inherently uncomfortable appears to preclude its long-term use in many positional OSA patients. As noted by Oksenberg et al.,<sup>5</sup> discomfort is also a problem with other OSA treatments, particularly continuous positive airway pressure.<sup>11</sup>

In conclusion, although tennis ball devices are simple, cheap, and ostensibly effective forms of positional therapy, most positional OSA patients prescribed them become non-compliant and untreated in the long-term, primarily because of the intrinsic discomfort associated with such therapies. Thus, improved therapeutic options appear to be needed for this important group.

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#### DISCLOSURE STATEMENT

This was not an industry supported study. The authors have indicated no financial conflicts of interest.

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#### APPENDIX

##### Questionnaire on use of the tennis ball technique (TBT)\*

1. When were you prescribed TBT?
2. Are you currently using TBT during sleep?  
If not, why don't you use TBT? Please indicate *main* reason(s):
  - I felt no improvement in quality of sleep or daytime alertness
  - TBT was ineffective in keeping me off my back
  - I found TBT too uncomfortable
  - With time, I learned to sleep on my side without it†
  - The tennis ball moved around
  - TBT caused backache
  - Other (please specify)

\*Based largely on that reported by Oksenberg et al.,<sup>5</sup> who kindly provided a copy of their original questionnaire on request. † Patients who selected this option were categorized into group B (see Methods).