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Positional Therapy for Obstructive Sleep Apnea Patients: A 6-Month Follow-Up Study

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Background: **Approximately half of obstructive sleep apnea (OSA) patients are positional (i.e., the majority of their breathing abnormalities during sleep appear in the supine posture). Little information exists as to whether avoiding the supine posture during sleep (positional therapy) is a valuable form of therapy for these patients.** ***Aim:*** **To assess the use of positional therapy (by the tennis ball technique [TBT]) during a 6 month period in 78 consecutive positional OSA patients.** ***Methods:*** **Demographic, polysomnographic, and self-reported questionnaire data on the use of the TBT were analyzed.** ***Results:*** **Of the 50 patients who returned the questionnaire, 19 (38%) (group A) said they were still using the TBT, and 12 (24%) (group B) said they used it initially and stopped using it within a few months but were still avoiding the supine position during sleep. Nineteen patients (38%) (group C) stopped using the TBT within a few months but did not learn how to avoid the sleep supine posture. Patients still using the TBT showed a significant improvement in their self-reported sleep quality ($P < .005$) and daytime alertness ($P < .046$) and a decrease in snoring loudness ($P < .001$). Patients of groups A and B were older than patients who did not comply with this therapy ($P < .001$). The main reason for patients stopping the use of the TBT in group C was that using it was uncomfortable.** ***Conclusions:*** **Positional therapy appears to be a valuable form of therapy mainly for some older aged positional OSA patients.** ***Key Words:*** **Positional therapy, supine posture, supine sleep, tennis ball technique, OSA, snoring.**

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INTRODUCTION

The treatment of obstructive sleep apnea (OSA) could be divided into surgical and nonsurgical means. Continuous positive airway pressure (CPAP), the use of oral devices, and losing weight are the most common nonsurgical therapies for this clinical entity. The use of CPAP is without question the most highly effective form of therapy for moderate to severe OSA patients.[1] Nevertheless, although initial acceptance is fairly good, adherence to CPAP is suboptimal, and the success of CPAP use in mild OSA patients is even more problematic.[2] The use of oral devices has been growing in the last years and has been used mainly for snorers and mild OSA patients. This form of therapy has demonstrated some good results but unfortunately also has some complications and deficiencies, and side effects are not rare.[3] Losing weight is probably the most logical form of therapy for a vast majority of OSA patients. Improvement could be accomplished even by a modest weight loss; however, the compliance with this form of treatment is often so low that it is frequently not a feasible therapy for many of these patients.[4]

Positional therapy[5] (i.e., the avoidance of the supine posture during sleep) is a less frequent form of therapy, but it appears to be an adequate form of therapy for positional OSA patients. Positional OSA patients have most of their breathing abnormalities while sleeping in the supine posture. By sleeping in the lateral position, those patients may have a marked reduction in the number of apnea-hypopneas.[6] The prevalence of positional OSA patients is high. In the largest study up to now, including 574 consecutive OSA patients diagnosed by polysomnography (PSG) in a sleep disorders unit, it was found that 55.9% had at least twice as many breathing abnormalities during sleep in the supine posture compared with the lateral position.[7] The prevalence of positional patients was higher in mild to moderate OSA patients (ranging from 65–69%) than in severe OSA. Recently, others[8] have corroborated these previous findings despite using a more strict definition of positional therapy. The high prevalence of positional OSA in the less severe forms of OSA is important because mild OSA patients are less likely to succeed with the treatment of CPAP[2] and therefore might be good candidates for positional therapy. Furthermore, because mild OSA patients are the vast majority of OSA patients,[9] if this form of therapy is successful, it could be used by a considerable number of OSA patients. The aim of this study was to assess the use of positional therapy during a 6 month period in 78 consecutive patients with positional OSA who chose to use this form of therapy rather than CPAP treatment.

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MATERIALS AND METHODS

Patients

Seventy-eight consecutive OSA patients diagnosed in our sleep unit for the first time (71 males) who had a clear positional effect (supine apnea/hypopnea index [AHI] at least double the lateral AHI) on their sleep-related breathing abnormalities and who refused CPAP treatment were offered positional therapy. Overweight patients were encouraged to lose weight. Patients with chronic obstructive pulmonary disease were excluded.

All the patients were taught the "tennis ball technique" (TBT) (see description below) and purchased the belt used in this technique for $7.50 US. We defined four groups of patients according to whether they returned the questionnaire and according to their successful or unsuccessful use of the TBT.

To objectively assess the effectiveness of the TBT to avoid the supine posture during sleep, 12 positional OSA patients not included in this group were evaluated in a second PSG study with the TBT. The mean time interval between the two PSG evaluations was 2.0 ± 2.2 months. These patients had similar demographic and PSG characteristics as the 78 patients included in the follow-up study. The ethical committee of the Loewenstein Hospital, Rehabilitation Center approved the study.

Tennis Ball Technique

Each patient bought a wide cloth belt that had a pocket into which a tennis ball was placed.[10] This belt was wrapped around the chest so that the pocket with the ball lay in the middle of the back. The idea is that whenever the patients rolled onto their backs, they would feel the pressure of the tennis ball and would roll back onto their side again. Six months after being given the belt with the ball, a questionnaire was mailed to all 78 patients (Table I).

Overnight Polysomnographic Evaluation

Complete overnight PSG was performed in all subjects, either with a polygraph (Nihon Kohden, models 4421 and 4414; Tokyo, Japan) or with the Rembrandt Manager System (Medcare, Amsterdam, The Netherlands), and included the standard parameters.[7] Sleep stages were scored manually according to the standard criteria.[11] Apnea was defined as an episode of complete breathing cessation of 10 seconds or longer and hypopnea as a reduction in oral/nasal airflow (thermistors) lasting 10 seconds or longer, accompanied with arousal or by a drop of at least 3% in SaO_2. The number of apnea plus hypopnea events/sleep hour (AHI) were calculated. Mild OSA was defined as AHI ≥ 10 and < 20; moderate OSA as AHI ≥ 20 and < 40; and severe OSA as AHI ≥40.

TABLE I.
Questionnaire on Use of Tennis Ball Technique (TBT).

Did you ever wear the belt and if so for how many hours did you sleep with it?
Did you wear the belt every night and if not how many nights a week?
Did the belt help you maintain the lateral position during sleep?
If you stopped wearing the belt why did you stop?
For what period of time did you use the belt?
If you stopped using it did you continue to sleep on your side even without it?
If so, how long did it take you to learn how to sleep on your side without the belt?
Did you notice any difference in snoring loudness, quality of sleep or excessive daytime sleepiness by using the belt?

Statistical Analysis

Demographic, PSG, and TBT data comparison between groups was assessed by one-way analysis of variance (ANOVA). We used the Kruskal-Wallis nonparametric ANOVA to compare between groups with regard to the effect of using the TBT on three ordinal scales: improvement in quality of sleep, daytime alertness, and decrease in snoring loudness. All data are presented as mean ± standard deviation. Results are considered statistically significant at the $P < .05$ level. Data were analyzed using SPSS (version 13.0) for Windows, (SPSS, Inc., Chicago, IL).

RESULTS

The main demographic and PSG data of the 78 positional OSA patients in the TBT follow-up study were as follows: age (years), 51.3 ± 12.1; body mass index, 28.1 ± 3.7; AHI, 25.5 ± 17.3; supine AHI, 52.8 ± 25.4; lateral AHI, 11.0 ± 13.5; Epworth Sleepiness Scale, 8.2 ± 4.8; total sleep time (TST) (minutes), 367 ± 47.7; lateral TST, 231 ± 90.5; supine TST, 133.7 ± 77.0; supine maximum snoring loudness (MSL) (decibels), 70.8 ± 7.3; lateral MSL, 55.9 ± 19.3.

Fifty (64.1%) patients replied by filling out and returning the questionnaire. Of these patients, 19 (38%) (group A) said they were still using the TBT, 12 (24%) (group B) said they used it initially and stopped but claimed that they were still maintaining the lateral position. The other 19 (38%) (group C) stopped using the device after an average period of a month but claimed that they did not learn how to sleep only on their side. The demographic and PSG characteristics of the four groups are seen in Table II. Duration of belt use was obviously different between the groups; the mean time the patients used the belt was 26 ± 4.7 weeks in group A and 4.1 ± 3.2 and 3.3 ± 3.8 weeks in groups B and C, respectively. The only demographic or PSG parameter that was significantly different between the groups was age. Age was higher in the two groups that were either still using the TBT (group A) or had learned to sleep on their side without the belt (group B) than in group C, who were neither using the belt nor sleeping on their side. The patients who never replied to the questionnaire (group D) were also younger than groups A and B.

We examined the homogeneity of the four groups regarding the level of severity of sleep apnea (Table III). No significant differences were obtained ($P = .69$). This result also included the number of patients in each group with a lateral AHI less than 10, which could be considered as "cured" patients by using effectively the TBT.

Table IV summarizes the improvement in sleep quality, snoring, and daytime alertness in the three patient groups who returned the questionnaire. No significant correlations were found between the AHI and the degree of improvement of these three parameters for the three patients groups (data not shown). However, patients still using the TBT (group A) reported a significant improvement in sleep quality ($P \leq .005$), a decrease in snoring loudness ($P < .003$), and an increase in daytime alertness ($P < .046$) compared with patients of the other two groups.

Table V summarizes the reasons for patients in group C stopping the use of the TBT without learning how to avoid the supine sleep posture. Often, more than one

TABLE II.
Initial Demographic and Polysomnographic Data of Four Groups of Obstructive Sleep Apnea Patients According to Positional Therapy Response.

	Group A	Group B	Group C	Group D
	Still Using Belt Successfully	Stopped Using but Learned to Sleep on Side	Stopped Using Belt but Did Not Learn to Sleep on Side	Never Replied to Questionnaire
Number of patients	19	12	19	28
Age, years	60.2 ± 11.2	55.6 ± 10.8	45.9 ± 11.1	46.8 ± 10.0*
BMI, kg*m^2	28.4 ± 3.1	27.3 ± 5.2	28.7 ± 2.9	28.5 ± 3.3
Total AHI	24.8 ± 17.1	29.3 ± 22.6	20.6 ± 14.8	24.0 ± 17.2
Supine AHI	55.6 ± 18.4	50.9 ± 28.7	51.9 ± 31.7	51.5 ± 26.2
Lateral AHI	10.0 ± 10.9	18.2 ± 22.8	11.0 ± 14.2	10.8 ± 10.3
Minimum SaO_2 REM	82.2 ± 11.5	83.4 ± 10.4	85.1 ± 11.3	83.8 ± 10.7
Minimum SaO_2 NREM	87.3 ± 5.4	85.9 ± 5.6	88.1 ± 5.7	85.2 ± 7.2
Snoring supine, dB	69.6 ± 6.4	69.2 ± 5.6	67.0 ± 18.1	72.3 ± 8.2
Snoring lateral, dB	55.9 ± 15.5	52.7 ± 19.4	48.7 ± 24.9	56.8 ± 21.7
ESS, units	6.8 ± 4.4	8.2 ± 5.4	8.9 ± 5.5	8.2 ± 4.9
Sleep time supine, min	151.9 ± 83.1	124.4 ± 81.5	140.3 ± 73.8	134.1 ± 82.4
Sleep time lateral, min	191.2 ± 59.9	243.4 ± 96.9	235.8 ± 96.8	246.5 ± 93.7
Total sleep time, min	351.1 ± 55.8	367.7 ± 29.5	376.1 ± 54.3	380.6 ± 40.2
Duration of belt use, weeks	26.4 ± 4.7	4.1 ± 3.2	3.3 ± 3.8*	

*$P < .001$.
BMI = body mass index; AHI = apnea/hypopnea index; REM = rapid eye movement; NREM = nonREM; ESS = Epworth Sleepiness Scale; Snoring supine and lateral = maximum snoring loudness in these postures.

reason was given. The main reason for stopping the TBT treatment was that the TBT was uncomfortable. Other common responses were the ball kept moving around, patients still slept on their backs even with the ball in place, and patients did not feel any noticeable improvement in sleep quality, snoring, or alertness.

The effect of using the TBT on several sleep parameters in 12 positional OSA patients is presented in Table VI. No changes in TST and sleep efficiency were observed, but improvement in slow wave sleep occurred. As expected, there was a significant increase in lateral sleep time and a decreased supine sleep time. The minimum SaO_2 in both REM and nonREM improved significantly. The back AHI did not decrease significantly because this average included only patients who had some supine sleep time for supine AHI calculations. The six patients in this group with no supine sleep time (showing an excellent effect of the TBT) were not included (it is not possible to calculate a supine AHI if there is no supine sleep), and thus the supine AHI does not represent a "real" value. The effect of TBT on AHI is showed in Figure 1. Seven (58%) of the 12 patients had an AHI less than 10. For two (17%), the TBT did not work. They slept on the ball and had a supine TST% of 51% and 54%, respectively. One patient had a worse AHI despite the fact that he slept less time supine. A possible explanation of his AHI worsening is that the night before the evaluation with the TBT, he had a night shift with almost no sleep, and thus he was very tired/sleepy.

DISCUSSION

The results of this study showed that the use of positional therapy appears to be a valuable form of therapy for a relatively high percentage of positional OSA patients. Sixty-two percent of the patients who returned

TABLE III.
Distribution of Patients According to Obstructive Sleep Apnea (OSA) Severity Level.

	Group A	Group B	Group C	Group D
	Still Using Belt Successfully	Stopped Using but Learned to Sleep on Side	Stopped Using Belt but Did Not Learn to Sleep on Side	Never Replied to the Questionnaire
Number of patients	19	12	19	28
Mild OSA	5 (26.3)	5 (26.3)	9 (47.3)	14 (50.0)
Moderate OSA	11 (57.9)	4 (33.3)	9 (47.3)	9 (32.1)
Severe OSA	3 (15.8)	3 (25.0)	1 (5.3)	5 (17.8)
Lateral AHI <10	12 (63.2)	5 (41.7)	13 (68.4)	16 (57.1)

Values are number of patients (%). Chi-square test for homogeneity of the groups regarding OSA severity showed no significant differences ($P = .69$).
AHI = apnea/hypopnea index; Mild OSA = AHI > 10, < 20; Moderate OSA = AHI > 20, < 40; Severe OSA = AHI > 40.

TABLE IV.
Subjective Improvements in Sleep Quality, Snoring, and Daytime Alertness by Using Tennis Ball Technique (TBT).

	Improvement Scale	Sleep Quality Patients (%)	Snoring Patients (%)	Daytime Alertness Patients (%)
Group A*	None	3 (15.8)	2 (10.5)	4 (21.1)
n = 19	Slight	5 (26.3)	4 (21.1)	6 (31.6)
AHI = 24.8 ± 17.1	Moderate	4 (21.1)	9 (47.3)	5 (26.3)
Still using TBT successfully	Great	7 (36.8)	4 (21.1)	4 (21.1)
Group B	None	5 (41.7)	5 (41.7)	5 (41.7)
n = 12	Slight	4 (33.3)	2 (16.7)	5 (41.7)
AHI = 29.3 ± 22.6	Moderate	2 (16.7)	5 (41.7)	1 (8.3)
Stopped using it but learned to sleep on side	Great	1 (8.3)	0	1 (8.3)
Group C	None	10 (52.6)	15 (78.9)	10 (52.6)
n = 19	Slight	5 (26.3)	2 (10.5)	6 (31.6)
AHI = 20.6 ± 14.8	Moderate	4 (21.1)	1 (5.3)	2 (10.5)
Stopped using it but did not learn to sleep on side	Great	0	1 (5.3)	1 (5.3)

*Patients who still use TBT (group A) had significant improvement in sleep quality ($P < .005$), a decrease in snoring loudness ($P < .001$), and an improvement in daytime alertness ($P < .04$) after Kruskal- Wallis nonparametric analysis of variance.
AHI = apnea/hypopnea index.

the questionnaire on characteristics of the use of the TBT claimed to have learned to avoid the supine sleep position either by continuing the use of the device or by learning to avoid this posture during sleep by using the TBT for a relative short period of time (about a month) and then discontinuing its use. This therapy was associated with a significant subjective decrease of snoring loudness and an improvement in sleep quality and daytime alertness for the majority of patients who were still using the TBT.

Age appears as the only parameter that significantly differentiated between patients who complied and those who did not comply with this form of therapy. Positional OSA patients who were still using the TBT and those who stopped using it but learned to avoid the supine posture during sleep were significantly older than the group that did not comply with this treatment. However, according to the standard deviations, the degree of overlap is not small, and thus these results should be taken with caution.

The role of age in the compliance with CPAP is somewhat controversial. Some authors have reported that age may be a factor for nonadherence with CPAP,[12] whereas others have stated that there is no independent effect of age on compliance with CPAP.[13] Our results suggest that for young positional OSA patients, positional therapy may be a less adequate form of therapy. These findings are somehow disappointing because, according to the largest study on positional OSA patients,[7] they are on average a little younger than nonpositional OSA patients. It is possible that younger OSA patients are looking for a more radical solution for their breathing abnormalities during sleep. The avoidance of the supine posture during sleep produces a significant improvement in sleep-related breathing abnormalities,

TABLE V.
Reasons for Stopping use of Positional Therapy, Tennis Ball Technique (TBT).

Cause	Number of Patients
Uncomfortable	10
Ball keeps moving	4
Causes backache	3
Still slept supine with it	4
Made subject nervous	1
No improvement in sleep, snoring, or alertness	4
Interfered with sex life	1
Kept forgetting to use it	1

TABLE VI.
Effect of Using Tennis Ball Technique (TBT) in 12 Positional Obstructive Sleep Apnea Patients.

	PSG 1 Diagnostic	PSG 2 With TBT	*P*
BMI, kg* m^2	28.2 ± 3.6	28.1 ± 3.4	NS
Sleep efficiency, %	80.9 ± 15.5	78.9 ± 17.7	NS
REM sleep, %	18.0 ± 5.4	19.9 ± 6.0	NS
SWS sleep, %	20.4 ± 8.3	27.7 ± 9.5	<.04
Total AHI	46.5 ± 19.9	17.5 ± 19.4	<.002
Supine AHI	57.0 ± 22.4	44.4 ± 28.7	NS
Lateral AHI	11.6 ± 8.2	13.8 ± 22.0	NS
Min SaO_2 REM	81.3 ± 9.9	90.3 ± 4.7	<.009
Min SaO_2 NREM	85.1 ± 5.6	89.9 ± 3.9	<.009
TST, min	340.7 ± 68.2	322.3 ± 76.4	NS
TST supine, min	259.8 ± 94.6	42.8 ± 68.4	<.0001
TST supine, %	79.0 ± 28.1	12.3 ± 19.7	<.0001
TST lateral, min	80.7 ± 109.4	276.7 ± 81.6	<.0001
TST lateral, %	21.0 ± 28.1	87.0 ± 19.4	<.0001

Mean time interval between the two PSG recordings was 2.0 ± 2.2 months.
PSG = polysomnography; BMI = body mass index; REM = rapid eye movement; NREM = nonREM; SWS = slow wave sleep; AHI = apnea/hypopnea index; TST = total sleep time.

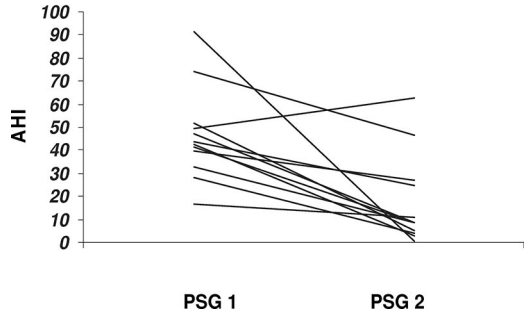

Fig. 1. Effect of positional therapy to avoid supine posture during sleep (using tennis ball technique [TBT]) on apnea/hypopnea index (AHI) in 12 positional obstructive sleep apnea patients. Polysomnography (PSG) 1 diagnostic; PSG 2 with TBT. In seven patients, AHI was reduced to less than 10.

but, because snoring may persist in the lateral postures,[14] this form of therapy may not be the ideal solution they are looking for. Accordingly, we did not find significant differences between MSL in the lateral and supine postures (Table II). Unfortunately, for this young population, CPAP treatment is often less well tolerated, and thus, for them, losing weight, the use of oral devices, or surgical procedures may be perhaps more practical solutions.

Most of the patients who stopped using the TBT after a short period of time claimed that they stopped because it was uncomfortable. Unfortunately, discomfort is also a problem with other forms of therapy for OSA including CPAP and oral devices. It is clear that adherence with an uncomfortable treatment is a real problem.

The TBT was probably first used by Kavey et al.[15] in the 1980s. Cartwright et al.[5] used an alarm system (activated when the patients rolled onto their backs), which markedly reduced supine sleep time (from 51.4% to 2.1%) and in most patients reduced the AHI to less than 10. Jokic et al.[16] compared 2 weeks of positional therapy with 2 weeks of CPAP in 13 mildly obese positional OSA patients. CPAP treatment was more effective than positional therapy in reducing respiratory events and preventing desaturations, but the treatments had similar efficacy in terms of sleep quality, daytime sleepiness, mood, quality of life, and daytime functioning.

The deleterious effect of the supine posture during sleep appears to be important also in patients with central sleep apnea and Cheyne Stokes breathing. Three recent studies[17–19] in stroke and heart failure patients have provided evidence showing that these type of breathing abnormalities are more prevalent in the supine than in the lateral position. Therefore, adopting the lateral position during sleep may represent a new and valuable behavioral approach for the treatment of breathing abnormalities during sleep in these patients. However, this topic requires further and extensive investigations.

Another point to be addressed is that the supine posture during sleep not only increases the frequency of apneic/hypopneic events but also increases their severity. The length of the apneic events, the degree of desaturation, the severity of the tachy-bradycardia changes after the apneic events, and the lengths of the accompanying arousals are all less severe in the lateral position than in the supine position.[20] Thus, adopting the lateral posture during sleep improves not only the frequency but also the nature of these breathing abnormalities.

This pilot study has several limitations, and therefore these data should be interpreted with caution. First, it must be taken into account that those who do not respond to mail surveys used for follow-up studies usually have poorer outcomes than those who are responders.[21] Thus, it is conceivable that the total outcome from all the patients in our study was actually worse than that found in those who did respond. Second, the data presented here are a subjective assessment of positional therapy with the TBT. No objective data on the compliance with the use of this technique was obtained. Thus, we really do not know how well the patients avoided the supine posture during sleep. However, on the basis of data of the positional OSA patients who had a PSG with the TBT, we can consider that most of the patients who did use the TBT had a marked reduction in supine sleep time and thus a significant reduction of the AHI. On the other hand, for some patients, this technique failed completely because they slept on their back without feeling the ball. Third, we did not have a placebo group for comparison. Last, no data on weight changes during the treatment period were obtained. Because of these limitations, our results are only preliminary and should be interpreted with caution.

We used the most accepted definition of positional OSA patients.[5] However, we believe as others do[8] that a more clinically oriented definition to be used in future studies should be supine AHI at least double the lateral AHI but with a lateral AHI less than 5 or at least less than 10, meaning that by sleeping in the lateral posture, there is not only a major improvement but a "cure" of this entity.

It is ironic that despite the fact that every sleep laboratory in the world records the body position changes during all PSG evaluations, in most cases, these data are not being used for anything except for being mentioned in the report. Most of the reviews on sleep apnea therapy either mention this form of therapy in a superficial way or do not mention it at all,[22] this despite the fact that over half the OSA patients are positional,[7] including over 60% of the mild OSA patients, who are the majority of the patients with OSA.[10] One could ask why it is that this kind of therapy has not been investigated more thoroughly and used more frequently. Unfortunately, there is a good reason for this. This topic totally lacks good randomized, controlled studies. Most of the studies in this area are small, nonrandomized, uncontrolled, and short term. If large randomized, controlled, and long-term studies were carried out, we might find that changing the body posture during sleep, a relatively simple behavioral maneuver, may have a powerful therapeutic effect on many sleep apnea patients and may thus help avoid the deleterious health and behavioral consequences of this disease.

CONCLUSIONS

Positional therapy, the avoidance of the sleep supine posture during sleep, appears to be a valuable form of therapy mainly for some older aged positional OSA patients. Because most of the positional OSA patients have

only a mild to moderate form of the disease, and because they are the majority of the OSA patients, positional therapy may represent an important form of therapy for a large number of OSA patients. Consequently, this form of therapy should be evaluated more extensively with special emphasis being placed on large randomized, controlled, and long-term studies.

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