Digital dentistry and dental sleep medicine

Paul Reaney[1]

Today in dentistry, there are so many technological advances that make diagnosis and treatment easier and better. Patients do well and providers are less stressed when these tools are utilised. Digital radiography, CBCT imaging, intraoral scanning, and dental software are but a few examples.

Recently, dental sleep medicine (DSM) providers have been advantaged by artificial intelligence (AI) applications, robotic manufacturing, and complex algorithms, which make diagnosis and treatment of sleep-related breathing disorders (SRBD) such as obstructive sleep apnoea (OSA) more predictable.

However, just as the clinician's differential analysis and procedural/material decisions have always guided good treatment recommendations, so too is the case for dental sleep medicine providers.

AI, enhanced by human intelligence (HI), is a powerful force in good clinical treatment and patient satisfaction. Indeed, great maths often needs the human touch.

Precision diagnostics

The 'stop-bang' (snoring, tiredness, observed apnoea, blood pressure, body mass index, age, neck size, gender) questionnaire is one of the most trusted screening tools for sleep apnoea.

Positive answers to three of the eight factors indicate moderate risk and four or more moves the level to high risk.

A patient presented at the clinic with a common risk factor for OSA. They were scheduled for a home sleep test (HST) using the Night Owl (as per NICE guidelines).

Results indicated an apnoea hypopnea index (AHI) of 17 events per hour. Essentially, this means there were 17 reductions in breathing flow of complete or partial obstruction of the airway, which lasted at least 10 seconds and resulted in a decrease in the blood oxygen saturation of 3%.

Normal sleep will have between zero and five events per hour, mild sleep apnoea is five to 15, moderate 15 to 30 and severe is more than 30.

We have seen patients with more than 60 events per hour. That means the sympathetic nervous system wakes the patient up enough to take a fuller breath once every minute.

Typically, this unbalance of the para and sympathetic systems during sleep causes sudden heart rate surges, cardiovascular challenges, and endocrine stress.

A fuller understanding of the pathogenicity and comorbidities of OSA should be appreciated, and are covered elsewhere. Figure 1 shows how many other conditions are worse in this subset of patients.

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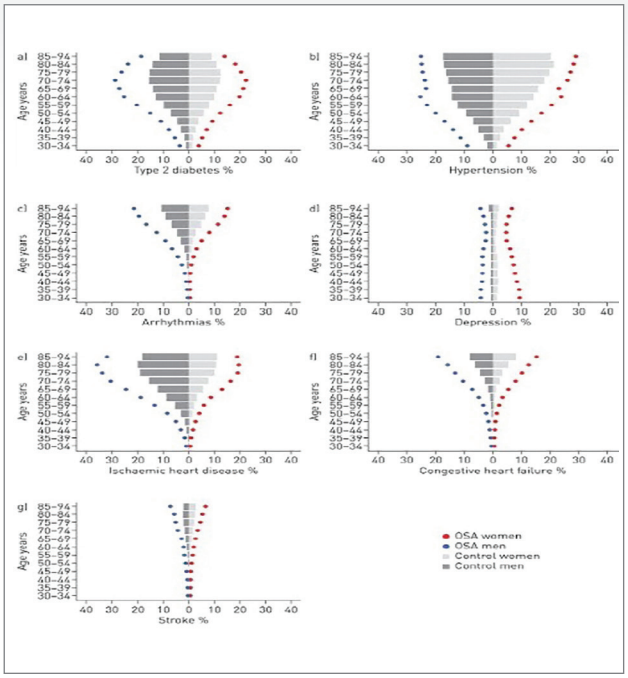


Fig 1: Graph showing how many other conditions are worse in this subset of patients

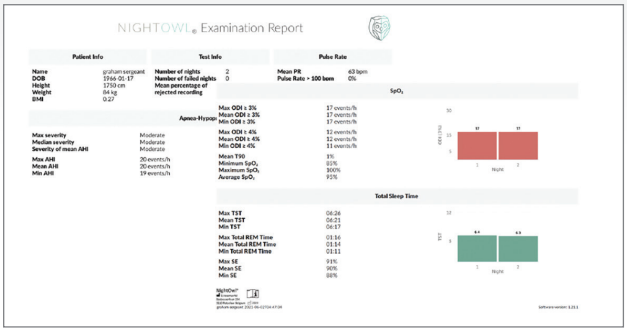


Fig 2: Precision HST with technology like the Night Owl

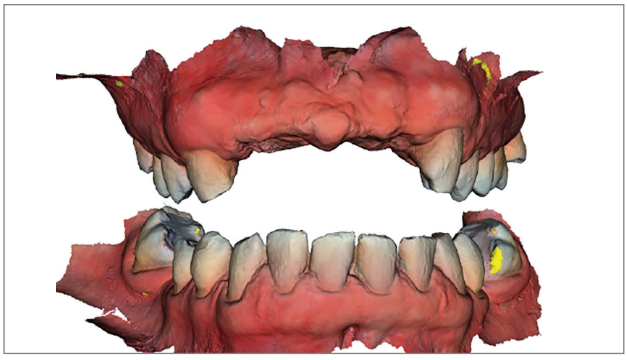


Fig 4: Scan

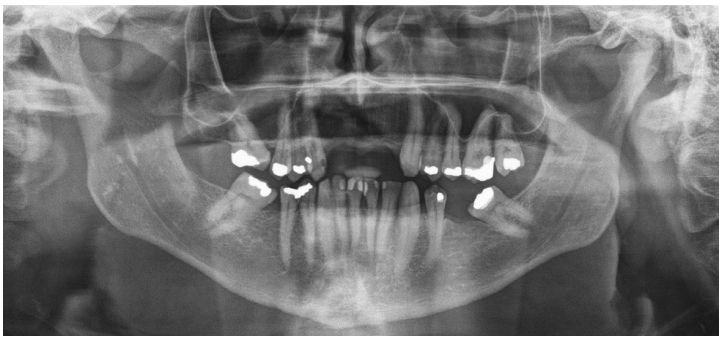


Fig 3: Patient radiograph

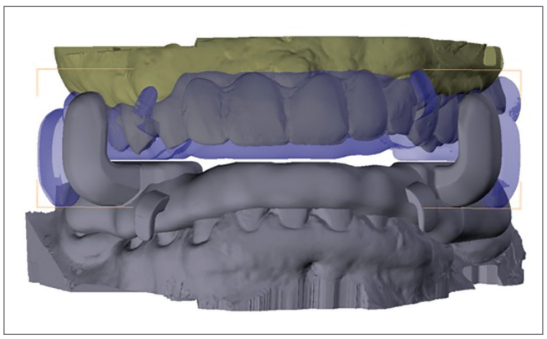


Fig 5: AI allows Prosomnus to replicate the patient's actual surface anatomy

Precision home sleep tests with technology like the Night Owl (Figure 2) are excellent ways to assess many of the patient's critical diagnostic and treatment confirmation metrics. This particular test allows for up to 12 nights over a two-year period.

Many clinicians prefer a two-night diagnostic test because up to 33% of mild and moderate patients can be misdiagnosed with a single night recording (Chung, 2008; Chung, 2012). Multi-night testing reduces failure rates and false negatives to 3% (Punjabi et al, 2002).

Precision records

Today, state-of-the-art in precision inputs for DSM require scanning the upper and lower arches along with a digital protrusive bite record at the prescribed starting position.

Carestream Dental has long been involved in certifying digital treatment protocols and pathways. When the CS 3500 was introduced, the company partnered with Prosomnus Sleep Technologies to establish a qualified all-digital pathway for inputting and manufacturing oral appliances.

Stop-bang questionnaire

The stop-bang questionnaire is an easy-to-use tool to identify people who might have obstructive sleep apnoea. The questionnaire consists of eight yes or no questions based on the major risk factors for OSA. Ask the patient the following:

- Snoring: do you snore loudly enough to bother a bed partner?
- Tiredness: do you feel tired during the day? This may include falling asleep during daily tasks
- Observed apnoea: has a sleep partner noticed that you stop breathing or gasp for air as you sleep?

Other considerations include:

- Blood pressure: high blood pressure is a symptom
- BMI: look for a body mass index that is higher than 35
- Age: those who are older than 50 are at higher risk for OSA
- Neck circumference: measure neck circumference – a measurement greater than 16 inches is considered a risk factor
- Gender: males are considered to be more likely to have OSA.

Fig 6: Appliance in situ

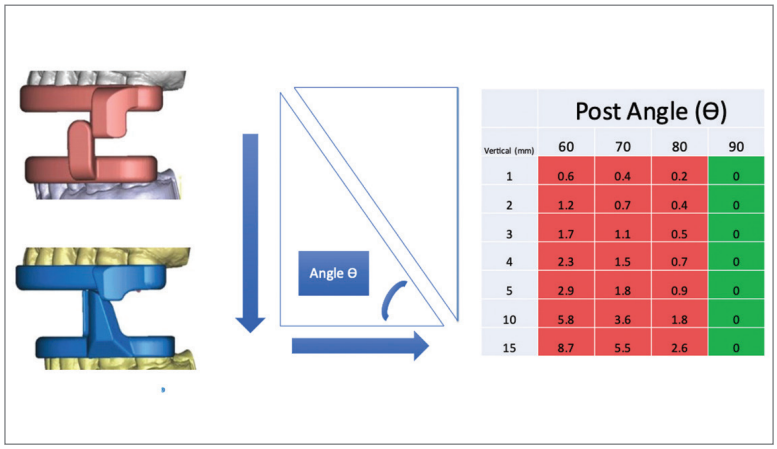


Fig 7: Angle analysis

The newer Dexis IS 3800 W intraoral scanner continues to provide the precision representations of the mandible, maxilla and inter-arch relationship that sets you up for success.

The input requirements from manufacturers like Prosomnus have raised the bar in providing precision medical solutions that reduce side effect risk, lower dose, and improve efficacy and patient comfort/adherence (Figures 3 and 4).

Precision treatment

Artisanal, handmade mandibular advancement devices (MADs) using cold and hot pot/pressure processed PMMA in combination with advancement parts and pieces borrowed from orthodontic applications (Herbst arms, jackscrews, and straps) were the standard until the advent of CAD/CAM and, now, AI design and robotic manufacturing.

Stronger milled PMMA and MG6 technology (Prosomnus Evo material) have allowed devices to be made smaller with more tongue space, improved comfort and better compliance.

The lower dose required by these advanced materials and manufacturing also have resulted in continued improvement of efficacy and fewer side effects. Tooth movement is non-existent (Vranjes et al, 2018), devices are easier to clean (Elliott et al, 2021), and patients prefer them over predicates and PAP solutions (Elliott et al, 2021). AI allows Prosomnus to replicate the patient's actual surface anatomy and deliver the device within 1.0mm of the prescribed starting position (Figure 5).

Iterative advancement is easier for patients, maintains the mandibular position (even with a relaxed mandible) and is bilaterally symmetrical.

These levels of precision were not possible until recently

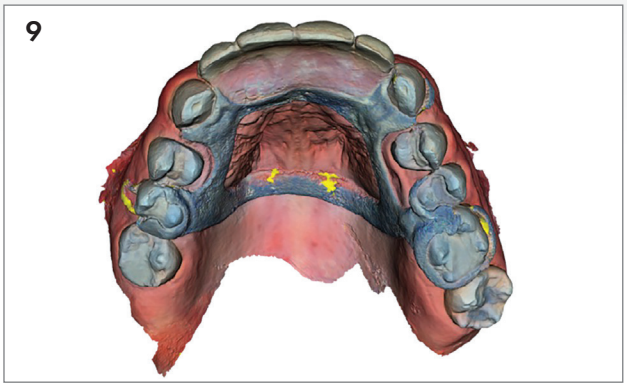
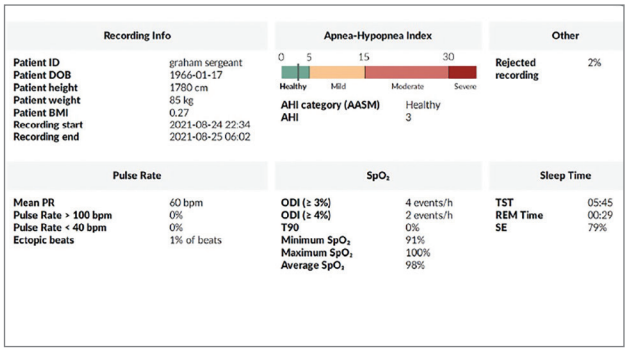


Fig 8 and 9: The software recorded the tooth anatomy from the over-scan of the partial denture

Fig 10: To simulate the look that the upper partial denture provided, the device had receptacles for composite

Fig 11: Prosomnus Evo in situ

Fig 12: Outcome



Recording Info		Apnea-Hypopnea Index		Other	
Patient ID	graham sergeant	0 5 15 30		Rejected recording	2%
Patient DOB	1966-01-17	Healthy Mild Moderate Severe			
Patient height	1780 cm				
Patient weight	85 kg	AHI category (AASM)	Healthy		
Patient BMI	0.27	AHI	3		
Recording start	2021-08-24 22:34				
Recording end	2021-08-25 06:02				
Pulse Rate		**SpO_2**		**Sleep Time**	
Mean PR	60 bpm	ODI (≥ 3%)	4 events/h	TST	05:45
Pulse Rate > 100 bpm	0%	ODI (≥ 4%)	2 events/h	REM Time	00:29
Pulse Rate < 40 bpm	0%	T90	0%	SE	79%
Ectopic beats	1% of beats	Minimum SpO_2	91%		
		Maximum SpO_2	100%		
		Average SpO_2	98%		

Fig 13: Final examination report

as the technology, material composition and manufacturing advanced to meet the needs of dental sleep medicine.

In my opinion, nobody makes devices the way Prosomnus does (Figures 6 and 7).

Precision humanisation

Even with all the technology, AI and robotic manufacturing, there is still room for, and a need of, the human touch. Software struggles to interpret our feelings and concerns.

The patient in this case was concerned with how the device would look at night to their spouse. Embarrassed at not having maxillary incisors, the clinician and Prosomnus collaborated on manufacturing a device with receptacles for composite to simulate the look that the upper partial denture provided.

This humanisation was a key factor in gaining case acceptance from both the patient and indirectly his spouse. The software was able to record the tooth anatomy from the over-scan of the partial denture and add them to the edentulous space (Figures 8 to 11).

Precision outcomes

In a perfect world, patients would improve their AHI to below five, have improved QOL scores, no side effects and excellent adherence.

For this patient, reducing the AHI from 17 to three events per hour would be a credible success indeed. Add to that, the patient reported sleeping better, was less tired, no longer snored and had more energy.

The smaller appliance and lower dose also resulted in excellent compliance, with the patient reporting they wore the appliance seven hours per night, seven nights per week. No reported side effects complete the matrix for successful outcomes (Figures 12 and 13).

References

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