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SLEEP MEDICINE PEARLS

Unusually Low Oxyhemoglobin Saturation on Polysomnography

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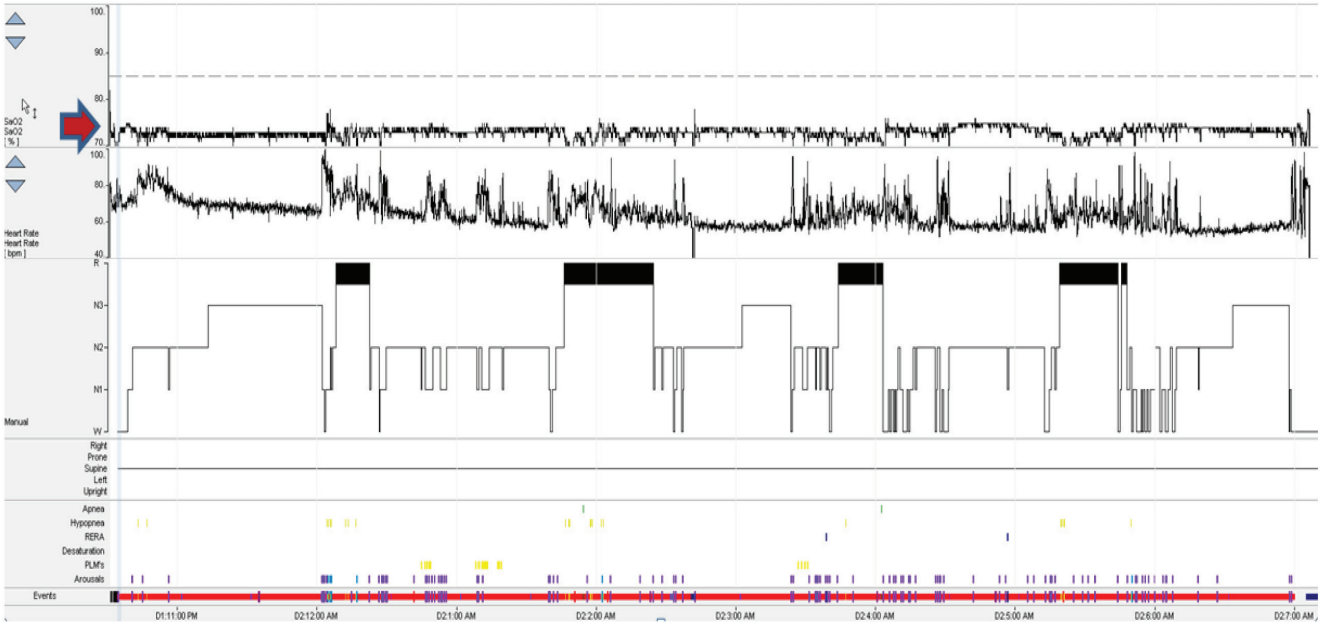
A 22-year-old male college student with prior diagnoses of mild obstructive sleep apnea, delayed sleep-wake phase disorder, and inadequate sleep hygiene presented to the sleep clinic for an evaluation of ongoing daytime hypersomnolence despite the use of mixed dextroamphetamine/amphetamine salts extended-release preparation (Adderall XR) 20 mg two times a day prescribed by his primary care provider for sleepiness.

He reported going to bed at 10:00 PM, falling asleep quickly, sleeping throughout the night until 8:00 AM, and not napping during the daytime but feeling extremely sleepy with an Epworth Sleepiness Scale score of 20/24. He described waking with a dry mouth but did not endorse snoring, snort arousals, or headaches upon awakening. There was no history suggestive of leg movements at night, cataplexy, hypnagogic/hypnopompic hallucinations or sleep paralysis. On examination, the patient had a patent oropharynx (Friedman grade I), neck circumference of 45 cm, body mass index of 36.63 kg/m², and normal blood pressure. Download from his continuous positive airway pressure (CPAP) device set at 11 cm H_2O pressure showed consistent usage for the entire reported sleep duration, minimal air leak, and a low residual apnea-hypopnea index. To evaluate his hypersomnolence further, the patient was tapered off his stimulant medication and two-week actigraphy followed by overnight polysomnography and Multiple Sleep Latency Testing (MSLT) was ordered.

QUESTION: What is the possible explanation for the significantly low oxyhemoglobin saturation (SpO_2) recorded through the entire polysomnogram (Figure 1)?

Figure 1—Hypnogram from overnight polysomnography.



The red arrow indicates oxyhemoglobin saturation. Mean saturation was 73% with a range of 66% to 78%. Hypopneas were scored when there was a further drop in oxyhemoglobin saturation from the baseline by ≥ 4% accompanied by a reduction in the nasal pressure signal by ≥ 30% for ≥ 90% of the event, each lasting ≥ 10 seconds. No apneas were noted during this study. The arousal index was 14.9 events/h and sleep efficiency was 93.6%. Sleep onset latency was 4.5 minutes and initial rapid eye movement latency was 89.5 minutes with 21% of the total time spent in rapid eye movement sleep. N1 = stage N1 sleep, N2 = stage N2 sleep, N3 = stage N3 sleep, PLM = periodic limb movement, R = rapid eye movement sleep, RERA = respiratory-effort related arousal, W = wake.

ANSWER: The patient had a low-oxygen affinity variant called hemoglobin Denver, which resulted in markedly low SpO_2.

DISCUSSION

Pulse oximetry is an integral part of polysomnography and utilizes spectrophotometry to determine the proportion of hemoglobin that is saturated with oxygen in peripheral arterial blood.[1] It has the advantage of being noninvasive and provides the opportunity to monitor SpO_2 data continuously.

Low SpO_2 on pulse oximetry may reflect true hypoxemia. Alternatively, this could result from conditions such as methemoglobinemia and sulfhemoglobinemia that are associated with reduced SpO_2 in the context of a normal arterial blood oxygen tension (PaO_2).[2,3] Venous pulsations secondary to venous congestion may result in artefactual low SpO_2.[4] Improper application of the oximeter probe and certain nail paints can also result in decreased SpO_2 readings.[5]

Inherited forms of abnormal hemoglobin, such as hemoglobin Denver in our case, can result in low SpO_2 despite a high fraction of inspired oxygen. Although there are more than 1,000 known hemoglobin variants, low-oxygen affinity variants that are associated with low SpO_2 are infrequent.[6,7] Patients with low-oxygen affinity variant hemoglobin may be completely asymptomatic or present with cyanosis but may otherwise be clinically well.[6,8]

Our patient's mother carried a diagnosis of hemoglobin Denver. Our patient, who was asymptomatic from the hematologic standpoint with no cyanosis on examination, had undergone evaluation by a hematologist prior to his sleep clinic referral; a DNA sequence analysis revealed that he too had this hemoglobin variant. Arterial blood gas showed a pH of 7.41, PaO_2 of 99.8 mmHg, $PaCO_2$ of 38.6 mmHg, oxygen saturation of 79.3%, bicarbonate level of 24 mEq/L, an A-a gradient of 0, and normal carboxyhemoglogin and methemoglobin levels.

The patient's actigraphy results demonstrated a regular sleep schedule with sufficient time spent in bed. Overnight polysomnogram consisting of a total sleep time of 474 minutes showed an apnea-hypopnea index of 3 events/h on CPAP and a periodic limb movement index of 3 events/h as well. Current scoring criteria[9] were used to determine disordered breathing events on polysomnography, although it should be borne in mind that in a case such as this, there may be a greater degree of desaturation during a given disordered breathing event to a right-shift in the oxyhemoglobin dissociation curve. The patient was found to have a mean sleep latency of 3.25 minutes (range of 2.0 to 4.0 minutes) on MSLT conducted the next day over four test nap opportunities while utilizing CPAP at the appropriate setting. He experienced two sleep-onset rapid eye movement periods, during naps 1 and 4. Results of urine toxicology for prescription and over-the-counter drugs performed during the MSLT were negative, including for stimulants. The patient's diagnosis was narcolepsy type II; the dose of his Adderall XR was increased to 60 mg in divided doses and a follow-up appointment scheduled in one month.

SLEEP MEDICINE PEARLS

1. Low saturation on pulse oximetry could result from a hemoglobin variant
2. Low SpO_2 in asymptomatic patients should raise the suspicion of a hemoglobin variant
3. Arterial blood gas analyses may help clarify the clinical picture
4. DNA sequence analysis can confirm the diagnosis of a variant hemoglobin
5. The technologist performing the polysomnography should be informed prior to the study of the anticipated low SpO_2 (if known) and decision whether to try CPAP or add supplemental oxygen should not be based on the SpO_2 alone

CITATION

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