Nocturnal Blood Pressure Fluctuation (NBPF) – a risk factor for heart attack and stroke during sleep

G. Kücher ①, H. Hein ②, I. Fietze ③
① Somnomedics GmbH, Randersacker, ② Sleep Laboratory, Reinbeck, ③ Interdisziplinaeres Schlafmedizinisches Zentrum Charité – Universitätsmedizin Berlin

Purpose
Obstructive Sleep Apnea Syndrome (OSAS) is highly correlated with cardiovascular diseases. Noninvasive Blood Pressure (BP) measurement, based on PTT (Pulse Transit Time), enables a reliable, continuous (beat by beat) and non-reactive (non-disturbing) BP measurement during sleep /1/. Transient increases of the nocturnal systolic BP (NBPF) of 27 mmHg and approx. 20 s duration are commonly observed at the end of obstructive apneas and hypopneas. Frequent NBPFs often lead to an increase of the baseline of the systolic BP (Superposition). Increases of the baseline in combination with NBPFs cause extremely high systolic BP peak values of up to 235 mmHg which imply a high risk factor for heart attack and stroke. In the present study, continuous non-reactive BP measurement was used to investigate the underlying factors causing the Superposition effect of the systolic BP during sleep.

Methods
25 patients (17 male, 8 female, age 54.4 ± 9.7 years, BMI 38.9 ± 8.5) with AHI > 20 were investigated by standard polysomnography (SOOMNOScreen™ plus, SOMNOmedics, Germany) in accordance to AASM. Systolic and diastolic BP indicated in minutes was determined continuously (beat by beat) by a PTT based method /2/. Continuous increases of the baseline of the systolic BP of >10 mmHg / 20 min were considered as “Superposition” and analyzed vs. “Non-Superposition” periods.

Principle of the Superposition
Increase of the baseline caused by frequent BP fluctuations

Results
In total we analyzed 55 periods of Superposition vs. Non-Superposition in 25 patients.

Superposition in begin, middle, end sleep period

Superposition and Sleep Stages

Superposition and Sleep Stages + Body Position

Non-Superposition[ ] vs. Superposition [ ]

Extreme systolic BP during Superposition periods

Conclusion
NBPFs of 27 mmHg and 20 s duration are caused by obstructive Sleep Apneas and Hypopneas /1/. These NBPFs, mainly present in REM sleep, often cause a rise of the baseline of the systolic BP (Superposition) which leads to inverse dipping behavior and high peak systolic BP. Due to an increased amplitude of the NBPF (53 mmHg) together with a rise of the BP baseline (26 mmHg), extremely high systolic BP peak values of up to 235 mmHg occur during Superposition periods. Since REM sleep periods are more frequent in the third part of the night, 84% of all Superposition periods are scored in the early morning. This finding agrees with observations of early morning infarct and stroke events. Standard parameters like AHI and OAI cannot uncover the additional risk caused by Superposition during sleep.

The effect of Superposition of the systolic BP is highly correlated (p ≤ 0.0001) to parameters of Hypoxia and systolic BP.

/1/ Harap et al. 2012 Messung von schnappweisen Blutdruckänderungen mittels Fieberthermometern und PTT-Prinzip. Arteriosklerose und Lungenerkrankungen 57-1-8
/2/ Geraci, F. et al., Continuous blood pressure measurement by using the pulse transit time: comparison to a cuff-based method. European Journal of Applied Physiology, 2013; 113, G., Penot, G. et al., Validation according to ESH International Protocol of SomnoScreen® NBP: a device for noninvasive continuous blood pressure monitoring. Poster at the ESH congress congress 2014, Athens