CIRCADIAN RHYTHMS OF RENAL FUNCTIONS IN PATIENTS WITH PARAPLEgia AND TETRAPLEgia

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HYPOTHESIS/AIMS OF STUDY
- The pathophysiological mechanisms of nocturnal polyuria remain unclear in para/tetraplegic patients:
  - Disturbed water diuresis: Inadequate or absent circadian rhythmicity in the secretion of the anti-diuretic hormone, vasopressin.
  - Disturbed solute diuresis: Fluid retention in the lower extremities during daytime leads to a higher nocturnal diuresis when changing to a recumbent position during the night.
- The objective of this study was to document the different circadian rhythms of the renal functions in an adult para/tetraplegic population compared to a control population.
- Clinical relevance: The presence of nocturnal polyuria requires extra catheterization or voiding during nighttime, otherwise, the maximal bladder capacity is exceeded and the bladder dilates. Consequently, this gives rise to complications such as autonomic hyperreflexia, incontinence episodes and recurrent urinary tract infections. Those sleep interruptions affect the quality of life of both the patient and his environment and lead to physical and mental disorders. 

STUDY DESIGN, MATERIALS AND METHODS
- Prospective observational study with the inclusion of:
  - 21 controls (since October 2011) who all met the following 3 criteria:
  - 25 cases (since June 2012) with a paraplegia or tetraplegia
- All participants collected a urine sample every 3 hours (table 1) during 24h to determine:
  - urine volume
  - urinary excretion of osmolality, solute, sodium, and urea

RESULTS
- Patient characteristics (table 2): Mean age was 47 ± 13.4 years in the cases and 49 ± 15.9 in the controls. Also gender was not significantly different between the 2 groups; 60% men in the cases and 57% in the control group. The mean nocturnal urinary volume was significantly higher (p=0.003) in the cases (1045 ± 528.7ml vs. 630 ± 315.1ml), which had a prevalence of nocturnal polyuria of 64-96%, depending on the definition used.
- Circadian rhythm of water diuresis (table 3 and figure 1): As the rate of osmolality excretion is a parameter for water diuresis, it is one of the contributing factors of urinary output. The mean 24h-osmolality excretion was significantly lower (p=0.001) in the controls (480 ± 30.4 mosm/kg) compared to the cases (646 ± 33.2 mosm/kg). There was no circadian rhythm in osmolality excretion in both groups.
- Circadian rhythm of solute diuresis (table 4 and figure 2): A major contributing factor of solute diuresis is urinary sodium excretion. The controls showed a circadian rhythm in sodium excretion, with higher sodium excretion during daytime (p=0.001). This was not observed in the cases, who also excreted significantly less sodium during daytime compared to the controls (p=0.019).

INTERPRETATION OF RESULTS
- Water diuresis: Although the participants were asked to drink their usual quantities, the cases showed a reduced diurnal influence of vasopressin. The lack of circadian rhythm in osmolality excretion suggests that an increased water diuresis, due to an impaired nocturnal vasopressin secretion, contributes to the high nocturnal urine volumes in para/tetraplegic patients. Also postural changes can influence vasopressin secretion and should therefore be taken into account in future research.
- Solute diuresis: The cases had no circadian rhythm in urinary sodium excretion and excreted significantly less sodium during daytime compared to the controls (p=0.019). These results suggest that also mechanisms involved in solute diuresis (atrial natriuretic peptide, renin-angiotensin-aldosterone system, postural changes, ...) contribute to the development of nocturnal polyuria in para/tetraplegic patients.

CONCLUSION
The lack of circadian rhythmicity in vasopressin secretion leads to an increased nocturnal water diuresis. Also sodium excretion showed a lack of circadian rhythmicity, with lower values during daytime, resulting in an increased nocturnal solute diuresis. Both the increased water diuresis and solute diuresis contribute to the occurrence of nocturnal polyuria in paraplegic and tetraplegic patients. Because postural changes can influence these pathophysiological mechanisms, it has to be taken into account in future research about nocturnal polyuria in paraplegic and tetraplegic patients.