Introduction

- Circadian variations and age-related changes in diastolic heart sounds and systolic time intervals have not been studied adequately with continuous assessment over long periods of time in a healthy population.
- Acoustic cardiography allows reliable assessment of hemodynamics via sound sensors and ECG electrodes placed on the chest for up to 48 h of continuous recording.
- Parameters produced by acoustic cardiography to assess
  - diastolic function 2: the presence of a 4th heart sound (S4) and left ventricular diastolic perfusion time (LDPT, interval from the second heart sound (S2) to the next Q onset) and
  - systolic function 3: the presence of a 3rd heart sound (S3), electrical mechanical activation time (EMAT) and left ventricular systolic time (LVST) (Fig. 1).

Methods

- 128 asymptomatic subjects (74 males (58%), age 48.1 ± 15.7, range 18 to 81 years) were enrolled in an ambulatory acoustic cardiography study (Audicor®, Inovise Medical, Inc.) (Fig. 2).
- A mean recording duration of 14 h including sleep time (awake 7.5 ± 3.2 hours, sleep 7.7 ± 1.3 hours) was analyzed for
  - the presence of a 3rd and 4th heart sound (S3, S4) and
  - systolic time intervals EMAT and LVST (Fig. 1)
- The S3 and S4 strength is a combination of intensity and persistence. It is expressed on a scale from 0 to 10 and if the strength is ≥2, S3 or S4 is considered to be present.
- Baseline demographics, medications and medical history, especially cardiovascular drug therapy and history of hypertension, was recorded.
- Results are given as mean values ± SD.

Results

- Heart rate decreased significantly during sleep in all age groups.
- Decrease in awake heart rate, but not during sleep, as age increased (only 2 subjects having taken β-blockers).
- Parameters reflecting systolic function:
  - EMAT had an increasing trend from age <40 yrs. to the age decades over 40 yrs. to a rather constant value of 89 ± 11 ms (Fig. 3).
  - EMAT had no significant circadian changes in all age groups (Fig. 3).
- After the age of 40 yrs. both awake and sleep %LVST (LVST normalized for cardiac cycle (RR-interval)) were constant regardless of increasing age.
- In the groups <40 yrs., there was a significant shortening of %LVST from awake to sleep (40.3 ± 4.1% awake vs. 36.3 ± 4.0% sleep).
- 3rd heart sound (S3) was significantly more prevalent under age 40 yrs. compared to persons over age 40 yrs. (13% vs. 3.6%) and significantly more pronounced during sleep in the younger group (19.6% sleep vs. 6.8% awake) as compared to the older group (4.8% sleep vs. 2.4 awake) (Fig. 4).
- Parameters reflecting diastolic function:
  - 4th heart sound (S4) was significantly more prevalent over age 60 yrs. compared to under 40 yrs. (23.5% vs. 5.6%) and significantly more pronounced during sleep of all ages >50 yrs., but particularly in the ages >60 yrs. (34.4% sleep vs. 12.6% awake) (Fig. 5).
  - LDPT was significantly longer during sleep as compared to awake in all groups (Fig. 6).

Conclusions

- In a healthy population, systolic time intervals (EMAT and LVST), reflecting left ventricular systolic function, demonstrate less change with age and less circadian/postural variation than diastolic heart sounds (S3 and S4).
- (Nocturnal) increase of S4 in the elderly reflects diastolic impairment – likely a result of changes in diastolic filling patterns with ageing.
- An S3 after the age of 40 yrs. is a relatively uncommon finding and therefore should be a specific sign of cardiac disease.

References