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Effects of Dobutamin on a Pulse-Transit-Time based blood pressure determination in relation to intra-arterial standard

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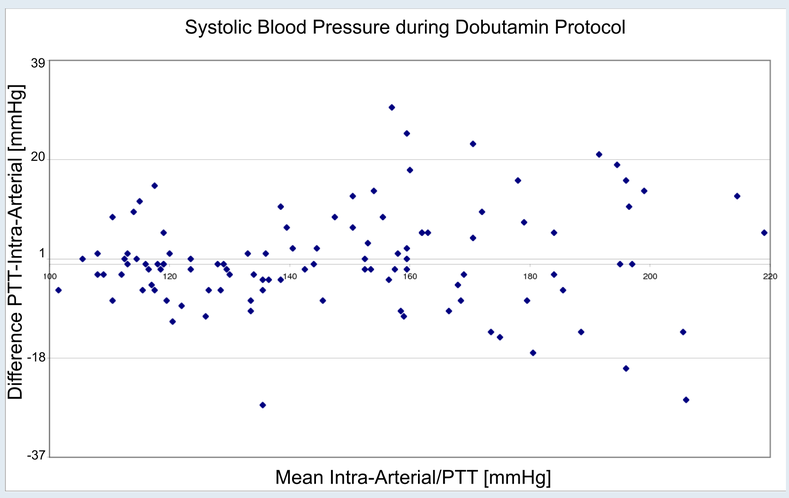
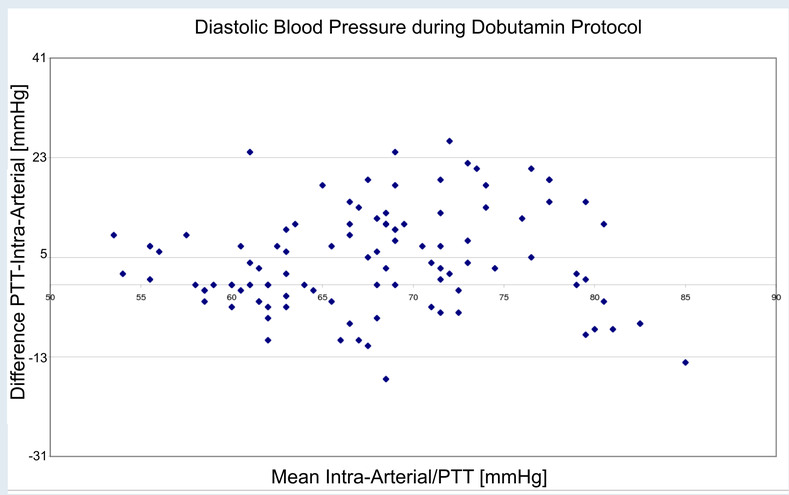
Introduction

Gesche et al. (2011) were able to show that a Pulse-Transit-Time (PTT) based blood pressure determination via a non-linear algorithm brings good results for systolic blood pressure values when compared to a cuff based method. Bartsch et al. (2010) tested the same algorithm on cardiologic patients and found a good correlation for systolic and diastolic values compared to blood pressure from invasive measurement. This was a first step to show the limitations of the PTT based method which needs a clear R-peak and a good signal from the fingerplethysmogram. In 2005 Payne et al. examined various drugs, which could influence the PTT. Whereas Glyceryl-Trinitrate, Angiotensin II and Norephinephrine did not affect the Pre-Ejection-Period (PEP) significantly, Salbutamol – a beta-2-Sympatomimetikum – did reduce the PEP from 91 to 30 ms and increased the heart rate at the same time from 66 to 125 beats per minute. Systolic Blood Pressure was not changed by this medication, but diastolic blood pressure decreased from 71 to 39 mmHg. For this study we decided to use the predominantly beta-1-agonistic drug Dobutamin, as the heart rate should not be influenced while there should still be a positive inotrope effect. The aim of this study was to show that PTT based blood pressure recording using a non-linear algorithm according to Gesche et al. (2011) is not influenced by Dobutamin.

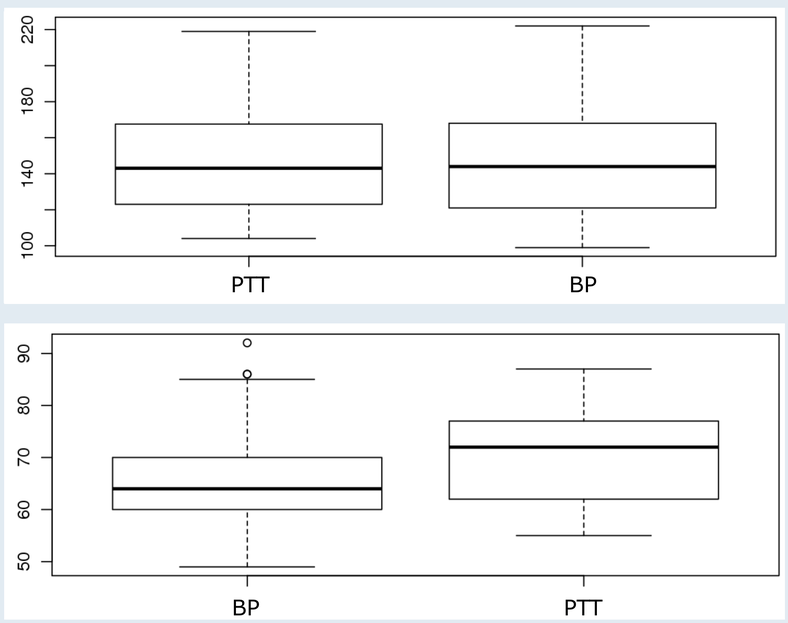
Results



Bland Altman Plot for Systolic Blood Pressure Values. For systolic blood pressure a correlation of 0.92 between the two methods was found with a standard deviation of 10 mmHg. There is an overestimation of 1 mmHg by the PTT method. Residuals are given as follows: Min -27, Max 31, 1Q -4, 3Q 4, Median -1, Standard Error is 9 on 105 degrees of freedom.



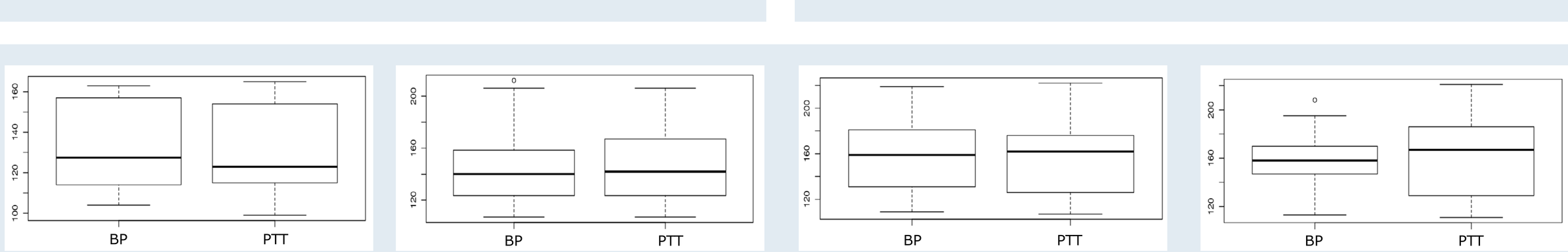
Bland Altman Plot for Diastolic Blood Pressure Values. For diastolic blood pressure a correlation of 0.4 between the two methods was found with a standard deviation of 10 mmHg. There is an overestimation of 5 mmHg by the PTT method. Residuals are given as follows: Min -16, Max 18, 1Q -7, 3Q 5, Median -1, Standard Error is 8 on 105 degrees of freedom.



Comparison of intra-arterial and PTT measurement. Left graphic: systolic values from PTT (left box) are comparable to the values from the intra-arterial measurement (right box). This high correlation could not be shown for the diastolic blood pressure [Right graphic: diastolic values from PTT (right box) and intra-arterial measurement (left box)].

Abstract

There are drugs like Salbutamol which are affecting Pulse-Transit-Time (PTT) because they change the time of the Pre-Ejection-Period (PEP) which is part of the PTT. The aim of this study was to find out if Dobutamin is affecting the PTT blood pressure determination, what could be shown with higher deviations while increasing doses of Dobutamin or blood pressure respectively. 12 subjects (5 females, 7 males) have been tested with an age from 21 to 53 (mean 29 years +/- 9 years) and BMI from 20 to 28 kg/m2 (mean 23 kg/m2 +/- 2 kg/m2). For systolic blood pressure a correlation of 0.95 was found with a mean deviation of 1 mmHg and a standard deviation of 10 mmHg. For diastolic blood pressure values the correlation was 0.42 with a mean deviation of 5 mmHg and a standard deviation of 10 mmHg. No significant trend of increasing deviations with increasing blood pressure or increasing dosage of Dobutamin could be observed. In conclusion low-dose Dobutamin is not affecting the PTT based blood pressure significantly and therefore suitable for stress echo together with PTT-based blood pressure determination.



Boxplots for increasing dosage of Dobutamin. Graphic 1: Mean BP of 120 mmHg before Dobutamin dosage. Graphic 2: 5 µg/kg body weight raises median BP up to 140 mmHg. Graphic 3: 10 µg/kg body weight raises median BP up to 160 mmHg. Graphic 4: 20 µg/kg body weight still increases BP for PPT method but not for intra-arterial measurement.

Discussion

It was shown that increasing Dobutamin levels going along with increasing blood pressure recorded via intra-arterial pressure measurement does not influence the PTT determined blood pressure values at low doses. At the point when the Dobutamin is no longer increasing blood pressure but increasing the heart rate the PTT method seems to become less reliable. But over all a good correlation for both methods was found for systolic blood pressure. The deviations of the systolic blood pressure are similar to those found from Gesche et al. (2011). The correlation found for the diastolic blood pressure is not as high as for the systolic blood pressure. The standard deviation for the PTT method is relatively high, but also the gold standard has some failure possibilities and is limited to clinical conditions, because there is a certain risk and some maintenance to be done (Martin et al. 2001).
The PTT based blood pressure determination is valid if Dobutamin is given in low dosage as needed for stress echo tests. So the PTT based method described in Gesche et al. (2011) is an alternative for continuous blood pressure recording e.g. during a stress-echo setting with Dobutamin. In addition the PTT blood pressure is non-invasive, what means that there is no risk of damage to vessels and nerves what means a maximum of benefit and comfort for the patient.

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