



# Non-invasive measurements of central blood pressure with arterial stiffness indicators as a new research tool for predicting cardiovascular risk in children with type 1 diabetes mellitus and obesity

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## Introduction

- The main problem of modern diabetology is the prevention of late complications in the course of carbohydrate metabolism disorders. Both type 1 diabetes (DM1) and obesity (predisposing to DM2) due to metabolic disorders affect the cardiovascular system by increasing vascular stiffness. It is therefore necessary to find simple tools that allow rapid identification of vascular lesions and early intervention with treatment.
- Blood pressure measurement is one of the simplest methods of patients' cardiovascular assessment and non-invasive measurement of Central Blood Pressure (CBP), with Augmentation and Amplification indices is accurately reflecting the condition of blood vessels and may be useful in monitoring of patients with diabetes. However, there are not enough studies in the pediatric population.

## Materials and methods

- The study involved 100 children matched in terms of age, body weight, height and sex (average age 13 years). The control consisted of 35 healthy children (Girls: 21, Boys: 14). The study group included patients with short-term DM1 < 5 years (G: 9, B: 12) and long term DM1 > 5 years (G: 12, B: 13) as well as patients with obesity (G: 9, B: 10) under the care of Department of Pediatrics, Endocrinology and Diabetology UDSK in Białystok
- Three consecutive measurements were made at 5 minute intervals using Centron Diagnostics' non-invasive cBP01 system connected to the brachial cuff and computer. Peripheral and central systolic and diastolic pressure as well as stiffness indexes - AUG - augmentation index and AMP - amplification index were determined, mean values were calculated. Statistical analysis was performed using Stat12.5 (student's t test)

## Results

	Control Boys	*DM1< 5 years B	**DM1> 5 years B	P C/**	*/**
SBP	122	115	121	0,14	0,49
DBP	67	69	70	0,56	0,13
HR	74	75	79	0,95	0,59
CBP	100	97	101	0,48	0,09
PP	33	28	29	0,09	0,75
AUG	0,58	0,62	0,59	0,54	0,31
AMP	1,78	1,65	1,75	0,57	0,33

\* DM1 <5 years since diagnosis

	Control Girls	DM1< 5 years G	DM1> 5 years G	P C/**	*/**
SBP	119	122	119	0,5	0,87
DBP	70	75	69	0,15	0,7
HR	85	84	86	0,7	0,34
CBP	99	104	97	0,16	0,72
PP	28	29	30	0,73	0,45
AUG	0,58	0,62	0,59	0,17	0,93
AMP	1,75	1,64	1,74	0,28	0,89

\*\* DM1 >5 years since diagnosis

	Control Boys	Obesity Boys	p
SBP	122	141	<0,05
DBP	67	77	<0,05
HR	74	80	NS
CBP	100	114	0,007
PP	33	36	NS
AUG	0,58	0,6	NS
AMP	1,78	1,71	NS

	Control Girls	Obesity Girls	p
SBP	119	147	0,001
DBP	70	88	0,005
HR	85	85	NS
CBP	99	124	0,004
PP	28	36	0,007
AUG	0,58	0,62	NS
AMP	1,75	1,69	NS

✓ Both in girls and boys with DM1 a clear trend was observed for unfavorable variability of vascular stiffness indexes (AUG/AMP for Girls C; G DM1<5 years; G DM1> 5 years → 0,58/1,75; 0,62/1,64; 0,59/1,74. Boys C: B DM < 5 years; B DM1 > 5 years → 0,58/1,78; 0,62/1,65; 0,59/1,75.) Without statistical relevance between groups.

- ✓ Patients with DM1 suffering > 5 years were characterized by a better AUG and AMP values than the DM1< 5 years group regardless of gender.
- ✓ Also regardless of gender, values of CBP did not show statistically significant differences.
- ✓ However, in obese girls and boys we observed statistically significantly higher values of CBP and PP (CBP/PP for Girls C vs OG → 99/28 vs 124/36, p=0,007; Boys C vs OB. → 100/33 vs 114/36, p=0,004/0,3)

## Arterial stiffness indicators

- AMP (Amplification Index)** - a healthy value of about 1.7 in a healthy young person. As we move away from the heart, the pulse wave amplitude (PP) should increase, then we talk about peripheral pulse wave amplification.
- Pulse pressure - PP** (difference between systolic and diastolic pressure). The smaller the difference between the peripheral and central pulse pressure, the stiffer the vessels (if the wave reflected returns faster to the heart, it increases the systolic pressure in the late-onset phase and does not apply to the diastolic pressure, generating an increase pulse pressure).
- AUG (Augmentation Index)**; This is the difference between the second and first peak of systolic heart rate as a percentage of heart rate  

$$AUG = AP / PP \times 100\%$$
  - PP = pulse pressure = (difference between systolic and diastolic pressure) AP = difference between pulse pressure 2 and 1 systolic peak

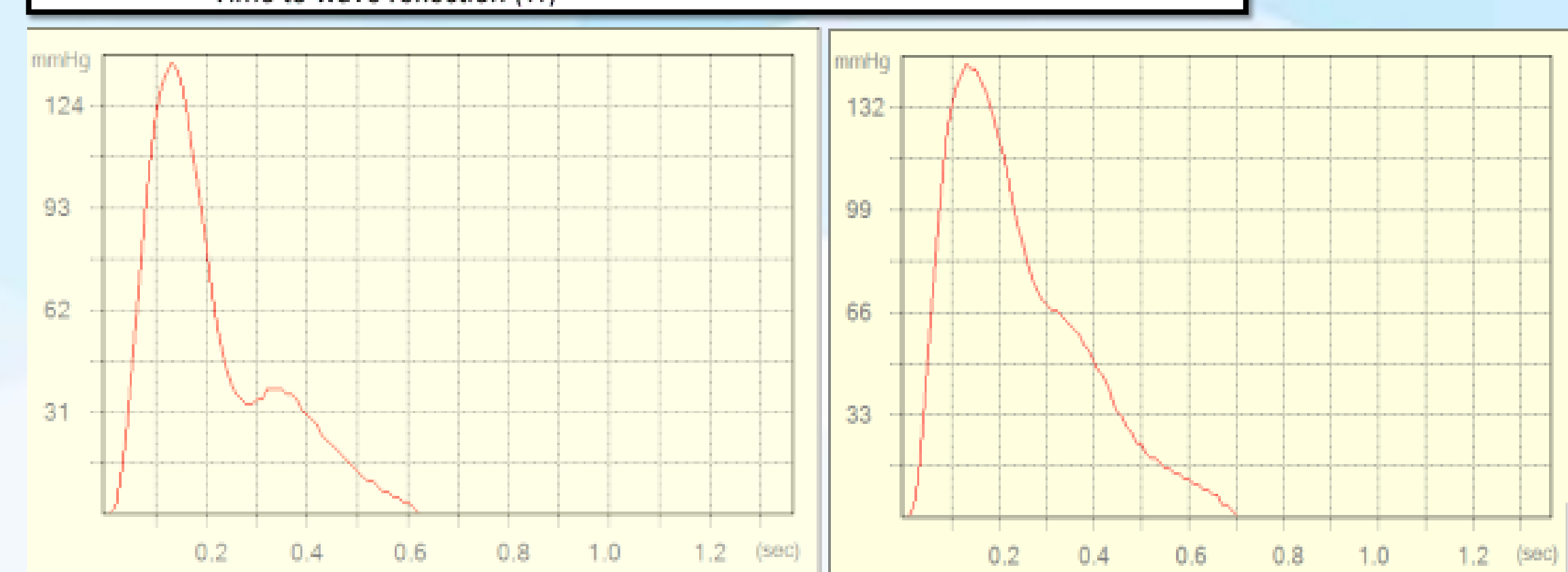
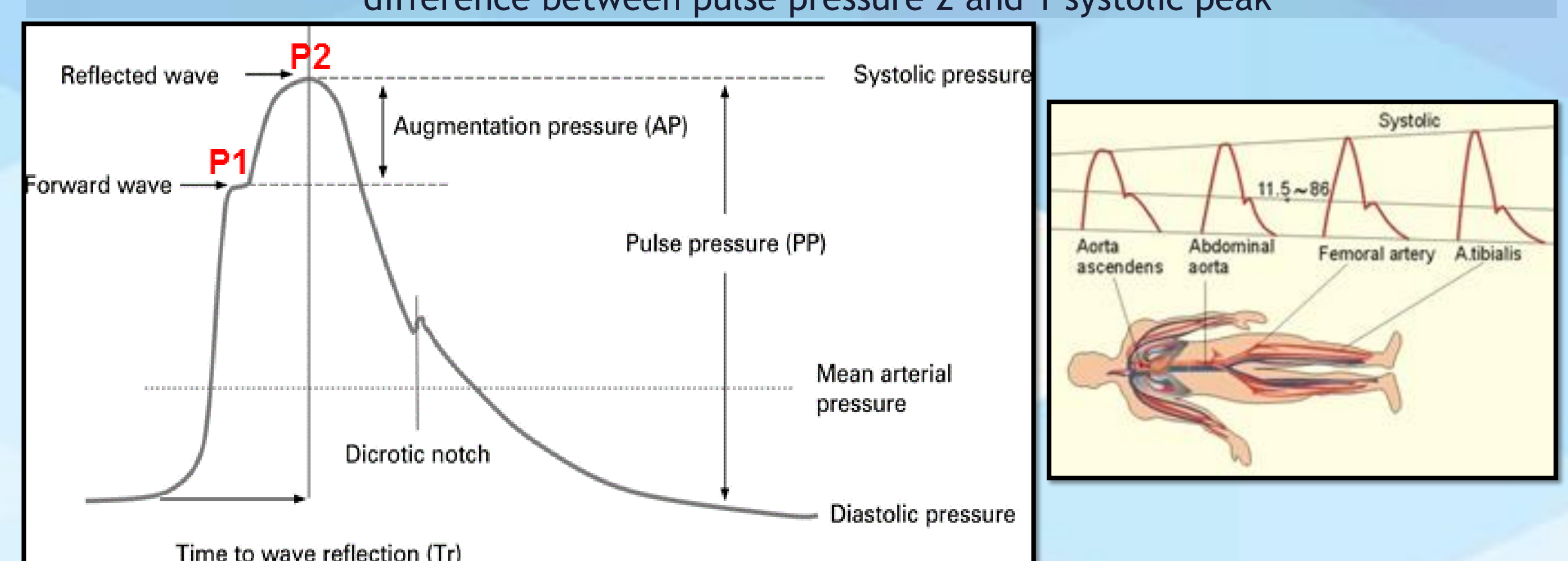
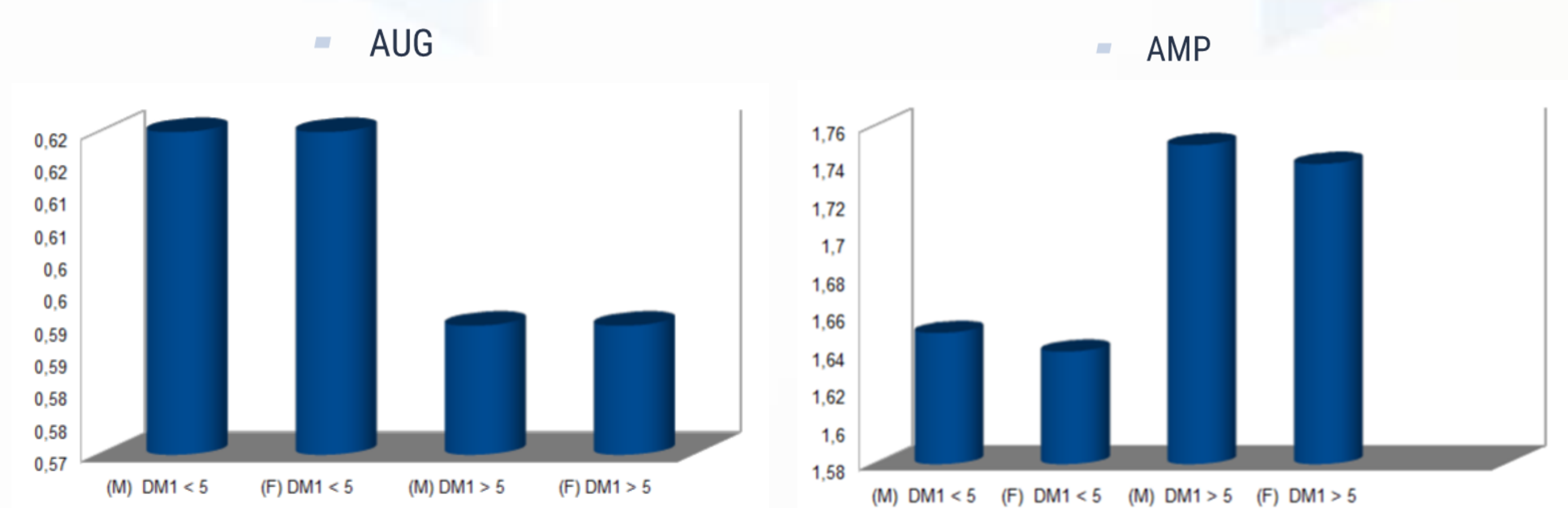


Figure 1. Correct central pressure diagram (control group)

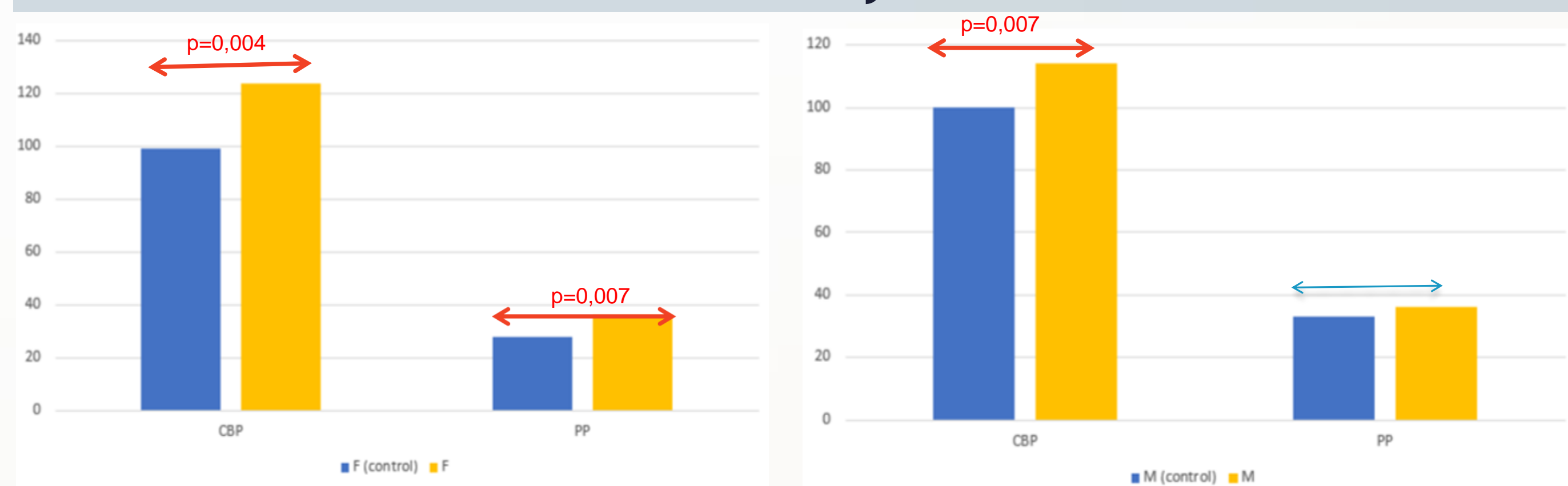
Figure 2. Incorrect central pressure diagram (example)



## Diabetes Mellitus type 1



## Obesity



## Conclusions

- Indices of vessels stiffness - Augmentation and Amplification showed a more favorable trend in children suffering longer from DM1 in the majority of those remaining on insulin pumps with better metabolic control.
- The values of the studied parameters were higher in the DM1 group < 5 years, possibly as a residue of ketoacidosis at the time of diagnosis or a higher percentage of patients treated with pens in this group.
- Obesity undoubtedly predisposes to increased central pressure parameters.

