ACCURACY AND PRECISION OF CONTINUOUS GLUCOSE MONITORING BEFORE, DURING, AND AFTER AEROBIC AND RESISTANCE EXERCISE IN SUBJECTS WITH TYPE 1 DIABETES

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Introduction

Continuous glucose monitoring (CGM) plays an important role in treatment decisions for patients with type 1 diabetes (T1D). Physical activity represents a great challenge for diabetes management and also for CGM systems [1,2].

In this work, accuracy and precision of the Medtronic Enlite-2 sensors (Northridge, CA, USA) were addressed before, during and after aerobic and resistance exercise in subjects with type 1 diabetes.

Materials and Methods

We analyzed data from a longitudinal, prospective, interventional study in subjects with T1D under CSII. The main objective of the study was the analysis of the limits of performance of a closed-loop controller when challenged by physical activity and the second objective was the analysis of the impact of exercise in continuous glucose monitoring accuracy. Each subject underwent three aerobic and three anaerobic exercise tests, completing six experiments in about nine weeks. In the day before the test, the patient inserted two sensors in the abdomen. PG samples were measured every 15 minutes using YSI 2300 Stat Plus Glucose Analyzer (YSI Inc, Yellow Springs, OH, USA).

Accuracy and precision of the CGM sensors were evaluated by the Median Absolute Relative Difference (MARD) and Precision Absolute Relative Difference (PARD). MARD and PARD were analyzed in six different periods (P0 to P5, all lasting one hour). In total, 36 exercise sessions were performed, in which two sensors were used per patient. From these 36 sessions, seven complete sessions and two sensors were discarded due to malfunction of YSI or CGM. The total of sensors analyzed for the aerobic and anaerobic sessions was 31 and 25, respectively.

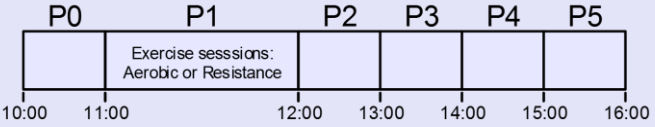

Figure 1 – Description of the periods considered in the analysis of MARD and PARD.

Conclusions

We concluded that the accuracy of sensors might be affected by aerobic exercise, although return to regular operation few hours after exercise period. The results presented should encourage the improvement of CGM technology in order to reassure robustness and safe of the device during physical activity.

Acknowledgment

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References

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Results

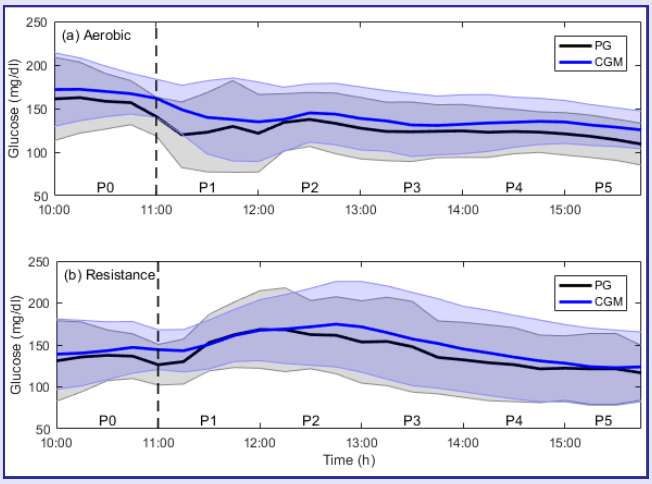

Figure 2 – CGM and PG measurements during the entire period of accuracy analysis. (a) Aerobic sessions: mean CGM was 142.53 ± 14.64 mg/dl and the mean PG was 130.53 ± 14.98 mg/dl. (b) Resistance sessions: mean CGM was 147.82 ± 16.29 mg/dl and the mean PG was 139.75 ± 16.58 mg/dl.

Aerobic Sessions

Table 1 – Accuracy and precision for aerobic sessions.

	MARD (%)	PARD (%)
P0	9.5 (4.7 - 13.9) n = 112	5.7 (2.2 - 9.1) n = 780
P1	16.5 (7.6 - 23.5) n = 108	9.7 (2.5 - 16.2) n = 757
P2	9.3 (5.4 - 16.3) n = 108	4.8 (1.5 - 10.0) n = 720
P3	11.6 (6.5 - 17.5) n = 108	5.8 (2.8 - 12.5) n = 720
P4	11.3 (6.2 - 16.0) n = 108	6.3 (2.1 - 9.6) n = 720
P5	12.9 (4.7 - 18.8) n = 108	5.2 (2.6 - 10.1) n = 702

Table 2 – p-value for MARD

p-value MARD						
	P0	**P1**	**P2**	**P3**	**P4**	**P5**
P0	–	<0,01	0,99	0,18	0,28	0,06
P1	<0,01	–	<0,01	<0,01	<0,01	<0,05
P2	0,99	<0,01	–	0,19	0,35	0,07
P3	0,18	<0,01	0,19	–	0,68	0,45
P4	0,28	<0,01	0,35	0,68	–	0,24
P5	0,06	<0,05	0,07	0,45	0,24	–

Table 3 – p-value for PARD

p-value PARD						
	P0	**P1**	**P2**	**P3**	**P4**	**P5**
P0	–	<0,01	0,08	0,06	0,85	0,57
P1	<0,01	–	<0,01	<0,01	<0,01	<0,01
P2	0,08	<0,01	–	<0,01	0,11	<0,05
P3	0,06	<0,01	<0,01	–	0,06	0,06
P4	0,85	<0,01	0,11	0,06	–	0,72
P5	0,57	<0,01	<0,05	0,06	0,72	–

Resistance Sessions

Table 4 – Accuracy and precision for resistance sessions.

	MARD (%)	PARD (%)
P0	15.5 (6.5 - 26.4) n = 76	9.2 (5.7 - 11.1) n = 420
P1	16.8 (7.9 - 24.5) n = 86	10.3 (5.4 - 14.0) n = 522
P2	12.7 (4.9 - 20.3) n = 88	9.6 (6.2 - 13.4) n = 540
P3	14.3 (4.8 - 26.5) n = 88	8.1 (3.4 - 12.3) n = 535
P4	14.3 (7.9 - 19.7) n = 89	7.9 (6.1 - 16.0) n = 540
P5	12.3 (5.7 - 18.8) n = 88	8.0 (5.6 - 11.2) n = 517

Table 5 – p-value for MARD

p-value MARD						
	P0	**P1**	**P2**	**P3**	**P4**	**P5**
P0	–	0,99	0,09	0,71	0,29	<0,05
P1	0,99	–	0,06	0,80	0,17	<0,05
P2	0,09	0,06	–	0,19	0,44	0,69
P3	0,71	0,80	0,19	–	0,46	0,08
P4	0,29	0,17	0,44	0,46	–	0,22
P5	<0,05	<0,05	0,69	0,08	0,22	–

Table 6 – p-value for PARD

p-value PARD						
	P0	**P1**	**P2**	**P3**	**P4**	**P5**
P0	–	0,14	0,10	<0,01	0,36	<0,05
P1	0,14	–	0,97	<0,01	0,58	<0,05
P2	0,10	0,97	–	<0,01	<0,05	<0,01
P3	<0,01	<0,01	<0,01	–	<0,01	0,07
P4	0,36	0,58	<0,05	<0,01	–	0,07
P5	<0,05	<0,05	<0,01	0,07	0,07	–