Effect of Lipohypertrophy on Accuracy of Continuous Glucose Monitoring in Patients With Type 1 Diabetes

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Repeated delivery of insulin in the same location induces a local reaction in the subcutaneous adipose tissue, often leading to lipohypertrophy (1,2). Advanced lipohypertrophy leads to slower, erratic insulin absorption due to the fibrous, relatively avascular nature of the tissue (3). Although lipohypertrophied tissue is commonly used for continuous glucose monitoring (CGM) sensor sites, the effect on sensor performance is unknown. Therefore, we analyzed the accuracy of sensors used simultaneously in lipohypertrophied and normal tissue.

In this prospective, multicenter study, subjects with type 1 diabetes and lipohypertrophy (≥3 cm diameter) were instructed to wear two Dexcom G4 Platinum sensors simultaneously: one in lipohypertrophied tissue and the second in normal tissue for 2 consecutive weeks. This procedure was then repeated on each subject with new sensors being worn simultaneously for a second 2-week period. Blood glucose (BG) readings from Bayer CONTOUR NEXT meters served as reference (4), with absolute relative difference (ARD) defined as the percent error between sensor and matched BG values. Only data from the first 7 days of sensor life were used in the analysis. The Mann-Whitney *U* test was used to compare the accuracy of the sensors in lipohypertrophied versus normal tissue. Results are presented as mean ± SD or median (interquartile range [25th%, 75th%]).

Twenty-nine subjects enrolled in the study. Baseline characteristics included 48% men, age of 29.6 ± 8.9 years, duration of diabetes of 17.3 ± 9.1 years, and hemoglobin A_{1c} of 7.5 ± 0.8% (58 ± 8.7 mmol/mol). The average diameter of lipohypertrophy was 8.1 ± 3.5 cm.

In total, there were 89,853 sensor glucose values between 40 and 400 mg/dL (range of sensor) with 1,547 corresponding BG readings. The median ARD for sensors in lipohypertrophied tissue was 10.0% (4.3, 17.2) versus 11.0% (4.9, 19.3) in normal tissue ($P < 0.001$). For BG ≤70 mg/dL, mean absolute difference (MAD) for sensors in lipohypertrophied tissue was 15 mg/dL ($n = 49$) compared with 18 mg/dL ($n = 48$) in normal tissue ($P = 0.14$). For BG ≥250 mg/dL, median ARD was 9.8% (4.6, 15.8) ($n = 341$) for sensors in lipohypertrophied tissue compared with 9.6% (4.8, 16.4) ($n = 334$) in normal tissue ($P = 0.44$) (Table 1).

In this analysis, CGM sensors in lipohypertrophied tissue showed equal or slightly superior accuracy to sensors in normal tissue. This was evident across all glucose ranges, with an overall median ARD of 10.0% for sensors in lipohypertrophied tissue.

The question remains as to whether sensors cause harm to the skin or subcutaneous tissue by repeated insertions in the same area. Although nothing is infused at sensor sites, the insertion and subsequent movement of the sensor tip might induce acute local trauma and possibly more chronic skin reactions (5). However, our data suggest that the flow of interstitial fluid is not adversely affected by the lipohypertrophied tissue.

To our knowledge, this is the first study evaluating the effect of lipohypertrophy on CGM performance. Our results suggest that lipohypertrophy does not adversely impact sensor accuracy. Further work is needed to quantify the potential risks of sensor use in areas of lipohypertrophy over longer periods of time.

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Table 1—Accuracy analysis of sensors in normal tissue compared with sensors in lipohypertrophied tissue

	Sensor in normal tissue	Sensor in lipohypertrophied tissue	*P* value
N of samples paired with reference meter value	1,537	1,547	—
Mean ARD	14.6 ± 15.0%	13.2 ± 14.3%	N/A§
Median ARD	11.0% (4.9, 19.3)	10.0% (4.3, 17.2)	<0.001
MAD for BG ≤70 mg/dL	18 mg/dL (*n* = 48)	15 mg/dL (*n* = 49)	0.14
Median ARD for BG ≥250 mg/dL	9.6% (4.8, 16.4) (*n* = 334)	9.8% (4.6, 15.8) (*n* = 341)	0.44
±20 mg/dL for BG ≤80 mg/dL*	66.4% (*n* = 104)	71.4% (*n* = 105)	0.34
±20% for BG >80 mg/dL†	79.9% (*n* = 1,433)	85.3% (*n* = 1,442)	0.003
Overall %20/20‡	79.0%	81.8%	0.051

Data are *n*, mean ± SD, or median (interquartile range [25th%, 75th%]), unless stated otherwise. *Proportion of all sensor values that were within ±20 mg/dL of reference meter value for BG ≤80 mg/dL. †Proportion of all sensor values that were within ±20% of reference meter value for BG >80 mg/dL. ‡Proportion of all sensor values that were within ±20 mg/dL of reference meter value for BG ≤80 mg/dL or within ±20% of reference meter value for BG >80 mg/dL. §Data not evenly distributed.

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