Early glycaemic control is predictive of long-term control: a retrospective observational study

C Jackson1,2
MBChB

EM Wernham3
MBChB

CJ Elder1,4
BSc, MBBS, MRCPCH

NP Wright5
MBChir, FRCPCH, MD

1University of Sheffield, Western Bank, Sheffield, UK
2Bradford Teaching Hospitals, Bradford, UK
3Whitehouse GP Surgery, Sheffield, UK
4Sheffield Children’s Hospital, Western Bank, Sheffield, UK

Abstract

There is a paucity of long-term data examining the relationship between early glycaemic control, in children and young people diagnosed with type 1 diabetes mellitus (T1DM), and long-term control. We wanted to determine whether early glycaemic control can predict long-term control. In addition, we examined whether initial presentation with ketoacidosis predicts future control.

A retrospective observational study of 155 children diagnosed with T1DM was undertaken examining HbA1c values collected over a 14-year period (1990–2004). HbA1c levels at diagnosis, over the first year after diagnosis and subsequent HbA1c were analysed by Pearson Correlation and multiple regression analysis to determine whether early glycaemic control is predictive of future, long-term control.

The cohort of 155 (81 male) currently aged between 2.4–18.3 years had a mean age at diagnosis of 6.6 years, with a mean duration of diabetes of 5.0 years. HbA1c levels at diagnosis (correlation coefficient 0.351, p<0.05) and within the first year (correlation coefficient 0.438, p<0.001) were significant predictors of long-term control; diabetic ketoacidosis at presentation had no predictive value (correlation coefficient -0.096, p=0.326). Multiple regression analysis indicated that the mean HbA1c level within the first year was the best predictor of the long-term HbA1c ($r^2=0.471$).

Early glycaemic control is predictive of long-term control. Health professionals seek to identify critical points in the evolution of T1DM at which to intervene in the hope of improving outcome, and this study identifies the first year as such a critical time. Copyright © 2013 John Wiley & Sons.

Practical Diabetes 2013; 30(1): 16–18

Key words

type 1 diabetes; children; HbA1c; predictors

Introduction

Type 1 diabetes mellitus (T1DM) is one of the most common chronic conditions seen in paediatric practice, with over 26 000 children affected in England and a UK prevalence of 1 per 700–1000.1 The publication of the Diabetes Control and Complications Trial (DCCT) demonstrated that the long-term effects of retinopathy, nephropathy and neuropathy were seen to correlate directly with glycaemic control.2 The subsequent paradigm shift in diabetes management has meant a much greater focus on tight glycaemic control.

Anecdotal observations suggest that children and young people (CYP) who obtain good early glycaemic control maintain good long-term control and, in contrast, in those whose control is poor shortly after diagnosis, it remains poor. There is, however, a paucity of research examining the long-term correlates of early glycaemic control. The Wisconsin Diabetes Registry reported that, although HbA1c was seen to rise during the first year following diagnosis, in both sexes and most age groups, this rise did not persist beyond the first year; however, less than five years of data were reported.3 Other work has focused more specifically on whether early glycaemic control correlates with long-term control, but numbers are small and no consensus exists.4,5 A retrospective study of 120 CYP with T1DM reported that HbA1c at diagnosis and after one year predicted subsequent glycaemic control.4 In contrast, a retrospective review examined data from a cohort of between 78 and 277 CYP, the number depending on the variable being studied, and found that HbA1c in the first year was not a good measure of long-term control but that poor glycaemic control in the second year was highly predictive of poor control in subsequent years.5

Although the psychological and social aspects of how CYP and their families adapt to and continue to manage the diabetes are undoubtedly...
Early predictors of glycaemic control

Methods

This retrospective observational study was conducted at Sheffield Children’s Hospital, UK. A clinical database is kept on all CYP with diabetes and, on entry to the database, consent is obtained to use the data for audit and research purposes. All CYP diagnosed with T1DM between January 1990 and January 2004 were assessed for eligibility. A total of 210 patients, aged between 2 and 18 years, were on the database of whom 155 were eligible for inclusion into the study. Eligibility criteria were age between 2 and 18 years and minimum of one year from diagnosis, with patients excluded if they had moved in or out of the area during the study period or had incomplete data sets, e.g. no HbA1c recorded after one year of diagnosis.

Three HbA1c parameters were compared: HbA1c at diagnosis, during the first year, and long-term HbA1c. HbA1c ‘at diagnosis’ was defined as a measurement taken within one month of diagnosis. The mean of the HbA1c results during the first year, excluding values within three months of diagnosis, was calculated. A ‘long-term HbA1c’ value was calculated by the mean of HbA1c values from the start of the second year after diagnosis until January 2004.

The patients’ basic details (e.g. sex, date of birth, date of diagnosis) and HbA1c levels throughout the course of their diabetes were extracted from the database. The patients’ medical records were examined for the HbA1c at diagnosis, whether they were ketoacidotic (DKA) at presentation and for any additional HbA1c measurements not recorded in the database.

Pearson Correlation coefficients were used to compare the relationship between HbA1c at diagnosis, mean HbA1c in the first year, presentation in DKA and subsequent control. Age, sex, age at diagnosis and duration of diabetes were entered into a multiple regression model. The dependent variable was long-term HbA1c and the independent variables HbA1c at diagnosis, mean HbA1c in the first year, DKA, age of patient, date of diagnosis, duration of diabetes and gender.

Results

The cohort of 155 CYP (81 male) with T1DM were aged between 2.4–18.3 years, with a mean age at the time of analysis of 12.0 years. The mean age at diagnosis was 6.6 years (median 6.1 years), with a mean duration of diabetes of 5.0 years (median 4.3 years).

The mean HbA1c at diagnosis was 103mmol/mol (11.6%). (Table 1.) However, only 28% (43/155) of the cohort had an HbA1c recorded at diagnosis, as measuring an HbA1c at diagnosis was not routine practice in the 1990s. Mean HbA1c within the first year of diagnosis was calculated in 97% of the cohort (150/155) and was 65mmol/mol (8.1%). The mean long-term HbA1c for the whole cohort (155/155) was 68mmol/mol (8.4%). Information about presentation in

<table>
<thead>
<tr>
<th>Variable</th>
<th>Years Mean (SD)</th>
<th>IFCC mmol/mol Mean (SD)</th>
<th>DCCT % Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at diagnosis</td>
<td>6.6 (3.8)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>HbA1c at diagnosis</td>
<td>–</td>
<td>103 (29)</td>
<td>11.6 (2.6)</td>
</tr>
<tr>
<td>HbA1c within first year</td>
<td>–</td>
<td>65 (16)</td>
<td>8.1 (1.4)</td>
</tr>
<tr>
<td>Mean long-term HbA1c</td>
<td>–</td>
<td>68 (11)</td>
<td>8.4 (1.0)</td>
</tr>
</tbody>
</table>

Table 1. Cohort variables with mean and standard deviations (SD)

Figure 1. Correlation between mean HbA1c in the first year and mean long-term HbA1c.
Early predictors of glycaemic control

DKA was available for 79% (122/155) of the cohort (as long-term microfilmed medical records were not retrieved) and 28% (34/122) had presented as ketoacidotic.

Analysis of the results using Pearson Correlation indicated that HbA1c at diagnosis correlated with long-term HbA1c (correlation 0.351, p<0.05). There was a significant correlation between HbA1c in the first year and long-term HbA1c (correlation 0.438, p<0.001). (Figure 1.) No correlation between DKA at presentation and long-term HbA1c (correlation 0.096, p=0.326) was observed.

Multiple regression analysis indicated that the mean HbA1c level within the first year was the best predictor of long-term HbA1c ($r^2=0.471$) contributing 47% of the variance in later HbA1c. Including HbA1c at diagnosis in the model, the $r^2$ value increased to 0.541. Other variables – DKA, age of patient, date of diagnosis, duration of diabetes and gender – were not significant predictors within the model.

Discussion

There are limited data on whether early glycaemic control can reliably predict the likelihood of a CYP’s long-term control in T1DM. The few studies that exist report variable results, involve relatively small numbers and lack long-term data, but suggest that early control is predictive of future control.4,5

We have shown a significant correlation between both HbA1c, at diagnosis and in the first year, and long-term HbA1c. The sample size included in the analysis of HbA1c at diagnosis was considerably smaller (28% vs 97%) and the relationship was not as strong. Our results are in keeping with those reported previously, where initial HbA1c is shown to have some predictive value on long-term control, but is less predictive than early HbA1c.4,6 It has been postulated that this is due to the impact of the partial remission or ‘honeymoon’ period.10,12 Results from the DCCT demonstrated that higher C-peptide levels at diagnosis were associated with reduced incidences of retinopathy and nephropathy suggesting that residual beta-cell function may improve long-term control.13

We have demonstrated, using data collected over a 14-year period, that attaining good glycaemic control in the first year after diagnosis is a strong predictor that an individual will maintain good control thereafter. These data help identify a potentially crucial window of opportunity for the diabetes team to direct more intensive interventional therapy at CYP in whom early control is poor.

Declaration of interests

There are no conflicts of interest declared.

References