Journal of Diabetes Science and Technology
Volume 6, Issue 5, September 2012

ORIGINAL ARTICLE

Autonomic Markers of Impaired Glucose Metabolism: Effects of Sleep-Disordered Breathing

Wenli Wang, Ph.D.,[1] Susan Redline, M.D., M.P.H.,[2] and Michael C. K. Khoo, Ph.D.[1]

Abstract

Background:

The association between diabetes and abnormalities in autonomic function is well-known, but it is not clear if this association can be extended to subjects with prediabetic impaired glucose metabolism (IGM). Sleep-disordered breathing (SDB), which commonly occurs in this population, is often overlooked. We sought to determine how autonomic function, monitored in an overnight sleep study setting, may be impaired in subjects with IGM and/or SDB.

Methods:

Polysomnograms (PSGs) selected from the Cleveland Family Study database were categorized into four groups: normal, SDB (respiratory disturbance index > 5/h), IGM, and both SDB and IGM. Impaired glucose metabolism was defined as an oral glucose tolerance test (OGTT) level > 140 mg/dl. Time-domain and frequency-domain indices of heart rate variability were used to quantify autonomic impairment. Baroreflex sensitivity determined using pulse transit time (BRS_{PTT}), an indirect measure of baroreflex sensitivity based on spontaneous pulse transit time fluctuations, was used as a surrogate measure of baroreflex sensitivity.

Results:

Based on 31 PSGs from subjects (16 males, 15 females) ages 20.8–61.2 years, both SDNN and BRS_{PTT} were found to be 20-25% lower in SDB and ~40% lower in IGM and SDB + IGM as compared to subjects without either condition. In analyses of continuous measures, mean standard deviation of 5 min R–R intervals (SDNN) and BRS_{PTT} were found to be negatively correlated with OGTT following adjustment for age and body mass index. Oral glucose tolerance test and age were the two most significant factors for predicting SDNN and BRS_{PTT}.

Conclusions:

Our analyses suggest that cardiac autonomic control is impaired in IGM, regardless of whether SDB is present. The abnormal autonomic function involves degradation of baroreflex regulation.

J Diabetes Sci Technol 2012;6(5):1159-1171

Author Affiliations: [1]Department of Biomedical Engineering, University of Southern California, Los Angeles, California; and [2]Department of Medicine, Harvard Medical School, Boston, Massachusetts

Abbreviations: (ANOVA) analysis of variance, (BMI) body mass index, (BRSPTT) baroreflex sensitivity determined using pulse transit time, (CFS) Cleveland Family Study, (ECG) electrocardiogram, (FBG) fasting blood glucose, (HRV) heart rate variability, (IFG) impaired fasting glucose, (IGM) impaired glucose metabolism, (IGT) impaired glucose tolerance, (mRRI) mean R–R interval, (OGTT) oral glucose tolerance test, (PLETH) photoplethysmograph, (PSG) polysomnogram, (PTT) pulse transit time, (RDI) respiratory disturbance index, (REM) rapid eye movement, (RRIHF) high-frequency power of R–R interval variability, (RRILF) low-frequency power of R–R interval variability, (RRILHR) ratio of low-frequency power to high-frequency power of R–R interval variability, (SDB) sleep-disordered breathing, (SDANN) standard deviation of the average R–R intervals calculated over 5 min periods, (SDNN) mean standard deviation of 5 min R–R intervals

Keywords: autonomic nervous system, baroreflex sensitivity, glucose tolerance, heart rate variability, pulse transit time, sleep apnea

Corresponding Author: Michael C. K. Khoo, Ph.D., Department of Biomedical Engineering, University of Southern California, DRB-140, 1042 Downey Way, Los Angeles, CA 90089-1111; email address khoo@bmsr.usc.edu