Diabetes and Diving

Diabetes is a disease in which the body is not able to produce or effectively respond to insulin, a hormone that is required to use glucose (sugar) in the blood. Healthy individuals maintain plasma glucose in a fairly narrow range from 70-110 milligrams per deciliter of blood (mg¥dL-1). Individuals with diabetes can experience dramatic fluctuations in plasma glucose. The primary acute concern of diabetes is that low levels of blood glucose (hypoglycemia) can impair consciousness. Long-term elevation of blood glucose (hyperglycemia) can result in circulatory problems and compromised vision.

The inability to produce insulin is known as Type 1 diabetes, or insulin-requiring diabetes mellitus (IRDM). The inadequate production of insulin or the insensitivity of the body's cells to insulin is known as Type 2 diabetes, or mature onset diabetes. Individuals with diabetes, particularly IRDM, have generally been excluded from activities during which a sudden loss of consciousness might pose significant risk. Scuba diving is one such activity, as impaired consciousness would certainly affect the diver's ability to take care of himself / herself or others. International differences have developed regarding guidelines for divers with diabetes. After learning of many individuals having dived successfully with IRDM, the medical committee of the British Sub Aqua Club (BSAC) relaxed a ban on participation in 1991. Those with IRDM are now allowed to dive within the BSAC system as long as they did not have cardiovascular or other complications.

The medical guidelines in the United States and many other countries have remained more conservative. Still, some authors have recommended case-by-case evaluation, and others have acknowledged that a relaxation in the guidelines will likely occur at some point in the future. In 1993, Divers Alert Network mailed surveys to all of its then-current 115,300 members to determine the numbers of active divers with diabetes, despite the ban at the time. A total of 164 divers with diabetes (129 with IRDM) described making more than 27,000 scuba dives with no major complications. Some reported experiencing symptoms of hypoglycemia, though none reported loss of consciousness. The effect of relatively benign recreational diving on plasma glucose levels is not well documented. DAN began a study in 1997 to investigate the response in certified recreational divers. The results of the study were recently published in the scientific literature. This report summarizes that study and describes future initiatives. Those who want the full details of the work should refer to the published article.

Methods

The plasma glucose response to recreational diving was measured in adult IRDM and healthy control divers. IRDM divers had a history of at least moderately controlled diabetes, were free of any secondary complications of diabetes, had not been hospitalized within the previous 12 months for severe blood sugar irregularities, and had a good understanding of the relationship between plasma glucose and exercise. Most dives were conducted from commercial liveaboard dive boats or day boats in subtropical or tropical waters. The divers' blood glucose had to be above 80 (mg¥dL-1) before each dive. Commercially available portable monitors were used to measure plasma glucose by finger stick. Values were recorded several times before and after the dives.

Results

Eighty-three divers participated in the study: 40 with IRDM and 43 as controls. Of 1,059 monitored dives, 555 were by divers with IRDM and 504 were by control group divers. The average IRDM diver was 45 years old, had been a diver for almost nine years and had diabetes for more than 15 years. Diabetes had already been diagnosed in 77 percent of the IRDM divers by the time they obtained scuba certification. Diving patterns were similar for IRDM and control groups, averaging 2.7 dives per day. No cases of decompression illness were reported. The variability in plasma glucose levels was dramatic in the IRDM

group, much more so than in the control group. There were no symptoms or complications related to hypoglycemia reported or observed during or immediately post-dive in either group. This was despite some low levels of plasma glucose. IRDM divers took extra glucose before nearly half of the dives. Post-dive plasma glucose fell below 70 (mg¥dL-1) after 7 percent of the IRDM group dives (minimum 41 (mg¥dL-1), and after 1 percent of the control group dives (minimum 56 (mg¥dL-1). Although symptomatic hypoglycemia was not reported immediately before, during or immediately after diving in IRDM divers, there were instances recorded at times unrelated to diving. Symptoms included: nausea, anxiety, shaking, feeling cold and headache. In several instances, these symptoms were enough to wake the diver in the middle of the night. Moderate levels of asymptomatic hyperglycemia (high blood glucose) of greater than 300 (mg¥dL-1) were noted on 67 occasions pre-dive and 17 occasions post-dive.

Discussion

There was considerable variability in the observed plasma glucose levels in IRDM divers, but low pre-dive values were easily corrected through a variety of feeding strategies. There are several important comments relating to the results of this study:

1. All of the divers with IRDM were well-motivated, experienced individuals with at least moderately controlled diabetes. Even so, there was considerable variability in the changes in plasma glucose levels, ranging from a rise of 283 (mg¥dL-1) to a fall of 370 (mg¥dL-1). The magnitude of the plasma glucose change was frequently noted with surprise by the divers, who had good experience in diabetes management. Conceivably, individuals with less stable IRDM or those normally maintaining very tight control could have an increased risk of hypoglycemia.
2. High plasma glucose may increase susceptibility to decompression sickness or worsen neurological decompression illness. Thus, simply elevating glucose levels to reduce the risk of hypoglycemia developing during a dive may not be a completely benign strategy.
3. Despite occasional instances of plasma glucose concentration in the 40-50 (mg¥dL-1) range, no reports of symptoms associated with hypoglycemia were recorded in this study. This fact suggests that, in some cases, a failure to recognize or report symptoms may have occurred. Equivalent low blood glucose levels experienced at other times of the day were noted and corrected.
4. Signs and symptoms associated with hypo/hyperglycemia may be confused with other medical conditions, such as hypothermia, nausea from seasickness, or possibly DCI.
5. All of the dives monitored were of an uncomplicated recreational nature conducted under minimal or modestly stressful conditions in tropical or subtropical waters. The additional stress associated with increased equipment, more severe water conditions, more extreme dive profiles or emergency situations could produce more dramatic fluctuations in plasma glucose.
6. This study enrolled adult subjects only. Children may be at greater risk due to increased distractibility, less experience in regulating plasma glucose and a physiological predisposition to greater variability in plasma glucose levels during exercise.

There are several practical concerns regarding the safety of individuals with diabetes being allowed to dive:

1. Symptoms of severe hypoglycemia include seizure and loss of consciousness, conditions likely to be fatal if experienced underwater.
2. There is no reliable means to take a rest from diving as there may be when exercising on land. Conditions may change rapidly and what had been a relaxed dive in benign conditions could turn into a very physically demanding situation.
3. Management of serious illnesses will be more difficult in remote areas.

4. The dive buddy standard is based on the assumption that both individuals can provide adequate and rapid support for a partner in time of need. This may not be true if one of the pair is impaired by a pre-existing medical condition.
5. Diabetes can be a progressive disease, and such progression may increase the risk of diving.