Resistance exercise as an intervention to improve glucose homeostasis

Background:

Metabolic complications, such as insulin resistance and Type II diabetes, represent a major individual and public health burden and are closely associated with obesity and physical inactivity. Even though medications are available to manage Type II diabetes, The American Diabetes Association states that **"physical activity and dietary modifications are central to the management and prevention of Type II diabetes"** and when medications are used to control Type II diabetes, **"they should augment lifestyle improvements, not replace them"**. However, inclusion of physical activity in a treatment program is not always the case.

Given the well-described long-term benefits of aerobic exercise for Type II diabetics, The American College of Sports Medicine currently recommends that insulin resistant/Type II diabetic populations should aim to perform moderate physical activity (i.e. brisk walking) for "**150 minutes each week, to be completed over 3 non-consecutive days"**. Alternatively, the effectiveness of long-term resistance training has not been thoroughly investigated. Thus, this mode of exercise is not currently prescribed to Type II diabetics. A growing number of investigators now believe that lack of resistance exercise recommendation is a mistake. Several years ago, a study in healthy, non-diabetic adults showed that a single session of high-intensity, leg resistance training, lasting roughly 45 minutes, improved insulin sensitivity 24 hours after the exercise. Currently the mechanisms controlling this response are unknown.

In addition to exercise, changes in dietary habits can also have a profound effect on plasma glucose levels and insulin sensitivity. It is understood that eating protein with a meal that is rich in carbohydrates can reduce plasma glucose levels in Type II diabetics. This effect is possible as the additional protein causes a greater release of insulin which signals to the muscles in our body to 'take in' glucose from the circulation. Currently it is unknown if protein feeding combined with resistance exercise can improve insulin sensitivity compared to either strategy alone.

Methods

We conducted an initial investigation in three groups of healthy, young adults to understand how a single session of resistance exercise lowers plasma glucose and improves sensitivity. We achieved this aim by asking to of the groups of participants to complete a heavy session of leg resistance exercise on two machines. A third group did no exercise, so acted as a control group. All participants reported back to the laboratory the following day to measure the ability of the body to tolerate a carbohydrate-rich drink, i.e. blood glucose and insulin sensitivity. In addition, one of the groups that exercised the previous day consumed protein with the carbohydrate-rich drink to determine if the protein had any additive effect (on top of the exercise) on blood glucose and insulin sensitivity. We also infused metabolic tracers into the blood stream of our participants and obtained small samples of muscle tissue from the thigh to gain important information about the mechanisms behind the changes in blood glucose and insulin sensitivity with resistance exercise and additional protein.

What did we find?

Similar to the previous study, we showed that a single session of resistance exercise improved insulin sensitivity and lowered blood glucose levels after the carbohydrate-rich drink was consumed the following day.

Furthermore, the metabolic tracers allowed us to show that previously exercised muscles removed the glucose from the bloodstream more quickly than the muscles of non-exercised individuals. Consistent with this notion, when analyzing muscle tissue samples, we found that the signals controlling glucose metabolism within the muscle were ‘turned on’ to a greater extent with exercise. Interestingly, inclusion of protein along with the carbohydrate-rich drink did not reduce plasma glucose response to a greater extent than exercise alone despite the fact that it did increase insulin levels.

Conclusions:

We demonstrated that high-intensity resistance exercise can improve glucose tolerance and insulin sensitivity in healthy, young adults. However, before this type of exercise is recommended to diabetics or those with insulin resistance, consideration of a few caveats must be made. First, the study population was not insulin resistant. A different metabolic response may occur in healthy muscles. Thus, it is perhaps worth investigating if insulin resistant populations have a similar response. Second, it may not be feasible for the majority of Type II diabetic patients to complete exercise of that intensity. Therefore, future studies with exercise of lesser intensity may be worthwhile. For the moment, this theory is yet to be tested.

Whereas we saw no additional effect of protein feeding on insulin sensitivity and glucose metabolism, it is clear that under day-to-day resting conditions protein ingested with carbohydrate is effective in lowering glucose levels in Type II diabetics. Thus, it is possible that the glucose lowering effect of resistance exercise may have been at an upper limit beyond which protein ingestion simply could not stimulate any further improvement. Alternatively, the lack of a beneficial effect of protein feeding may be limited to healthy, young adults. Since their baseline level of insulin sensitivity is already high, the ability to improve may be limited. Thus, if the experiment were repeated in Type II diabetics, it is possible that protein feeding after resistance exercise may be beneficial to metabolic health. Another issue to consider is that many of the studies demonstrating a positive effect of protein used protein with a greater amount of the amino acid, leucine, in the drink. Leucine has been identified as an important stimulator of the signalling pathways inside muscle that control glucose metabolism. Thus, it is possible that additional leucine may be necessary before the protein ingestion will contribute more to improvements in glucose control. More research is necessary to determine the ideal combination of exercise and nutritional interventions to increase insulin sensitivity.