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ORIGINAL RESEARCH

Evaluation of the relationship between the pelvic floor muscles and insulin resistance

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Purpose: The aim of this study was to evaluate the pelvic floor muscles (PFMs) in women with insulin resistance (IR) using surface electromyography and to associate the results with insulin levels.

Patients and methods: Through an analytical, cross-sectional study, 86 women were evaluated and divided into two groups: a control group (n=35) and an IR group (n=51). Data were collected through detailed history-taking, physical examination, and biochemical analysis. Fasting insulin levels were used for diagnosing IR. Electromyography of the PFMs was used for analyzing the tone and maximal voluntary contraction (MVC). The measures of central tendency and linear regression models were used.

Results: The average age was 25.3±4.5 years in the IR group and 27.2±4.4 years in the control group. The mean weight was 75.6±17.6 kg and 51.8±4.9 kg in the IR and control groups, respectively. Fasting insulin levels were 19.7±6.6 µIU/mL in the IR group and 5.4±1.8 µIU/mL in the control group ($P<0.010$). There were significant differences between the groups with regard to PFM tone (IR: 13.4±3.4 µV; control: 25.1±3.3 µV; $P<0.001$) and MVC (IR: 47.6±4.5 µV; control: 64.3±5.0 µV; $P<0.001$). Multiple linear regression analysis using the insulin levels as dependent variable showed a significant association for MVC ($P=0.047$), weight ($P=0.017$), and waist circumference ($P=0.000$).

Conclusion: Compared with the control group, the IR group showed lower electromyographic activity of the PFMs, and there was an association between insulin levels and electromyographic activity.

Keywords: tone, maximal voluntary contraction, woman, electromyography, menstrual cycle

Introduction

The pelvic floor muscles (PFMs) are composed of a set of skeletal muscles. The levator ani muscle forms the main structure and is composed of three muscles: pubococcygeus, iliococcygeus, and puborectalis. These muscles are responsible for providing support to the static and dynamic internal pelvic organs and for the closure of the urethral sphincter, allowing urinary and fecal continence.[1]

Particularly, in the region of the female urethra beyond the striated and smooth muscle, there are connective tissue cells disposed between the urethral sphincter muscle tissue. It is observed that, in the case of muscular weakness that culminates in urinary incontinence, there is a change in the composition, distribution, and organization of the extracellular matrix components of these different regions of the urethral tissue.[2,3] Changes in the extracellular matrix can also be observed in diabetic individuals and

Hormone levels were measured, and EMG was performed on the seventh day (follicular phase). Progesterone was measured only on the 21st day of the menstrual cycle to confirm ovulation.

The data were tabulated using the SPSS 19.0 software for Windows. The normality of distribution was assessed using the Shapiro–Wilk test. Central tendency measures were used to describe gynecological and obstetric data and laboratory tests. Student's t-test was used to compare EMG results between the groups. Pearson's correlation and linear regression adjusted for weight, BMI, waist circumference and tone was used to associate electromyographic activity and anthropometric variables with insulin levels in the IR group. A significance level of $P<0.05$ was used.

This study was approved by the Research Ethics Committee of the Federal University of Rio Grande do Norte under protocol number 150/07; all participants were informed about the study objectives and they provided informed consent for participation.

Results

The clinical and hormonal profiles of the patients are shown in Table 1. The average age was 25.3±4.5 years in the IR group and 27.2±4.4 years in the control group. The mean weight was 75.6±17.6 kg and 51.8±4.9 kg in the IR and control groups, respectively. Fasting insulin levels were 19.7±6.6 µIU/mL in the IR group and 5.4±1.8 µIU/mL in the control group ($P<0.010$).

The average PFM tone was 13.4±3.4 µV in the IR group and 25.1±3.3 µV in the control group ($P<0.001$). There was a significant difference ($P<0.001$) in MVC between the IR group (47.6±4.5 µV) and control group (64.3±5.0 µV) (Table 2).

Table 1 Clinical and hormonal characteristics of the patients

Variable	IR (n=51)	Control (n=35)	P-value
Age (years)	25.3±4.5	27.2±4.4	>0.05
Age of menarche (years)	14.4±2.6	14.3±3.1	>0.05
Weight (kg)	75.6±17.6*	51.8±4.9*	0.04
BMI (kg/m²)	30.1±5.7*	20.9±2.4*	<0.001
Normal	21.2%	100%	
Overweight	24.2%	0%	
Obese	54.6%	0%	
Waist circumference (cm)	90.3±14.8*	73.4±5.4*	<0.001*
TSH (µU/mL)	2.3±1.8	1.44±0.8	>0.05
Fasting glucose	94.5±6.3	71.8±4.1	0.03
Fasting insulin	19.7±6.6*	5.4±1.8	<0.001*

Note: *Significant difference with Student's t-test.
Abbreviations: BMI, body mass index; IR, insulin resistance; TSH, thyroid-stimulating hormone.

Table 2 Data regarding electromyographic activity in women with and without IR

Group	IR group	Control group	P-value
Tone (µV)	13.4±3.4*	25.1±3.3*	<0.0001
MVC (µV)	47.6±4.5*	64.3±5.0*	<0.0001

Note: *Significant difference with Student's t-test.
Abbreviations: IR, insulin resistance; MVC, maximal voluntary contraction.

Adjusted multiple linear regression analysis was performed in the IR group. This identified an association between insulin levels and MVC ($P=0.047$), weight ($P=0.017$), and waist circumference ($P=0.000$) (Table 3).

Discussion

This study is the first to research the electromyographic activity of the PFMs and IR. Our results showed that the EMG values related to tone and MVC in the IR group were lower than those in the control group.

Two cross-sectional analyses using the US National Health and Nutrition Examination Survey III data reported that higher muscle mass is associated with lower IR and lower risk of diabetes, independent of obesity.[9,12]

In our study, the participants in the IR group were overweight; in contrast, in the control group, all the participants had normal BMI. It is known that there are genetic links among waist–hip ratio, BMI, and IR.[13] This fact supports the high weight in the IR group in our study.

Moreover, the results indicated an association between insulin levels and MVC, ie, the higher the insulin change, the lower the electromyographic parameters of MVC. It is believed that skeletal muscles can adapt to metabolic demands to maintain a normal energy balance and nutrient use. This type of muscle structure is important for glucose uptake; a reduction in muscle mass and changes in the fiber type composition can directly affect acute glucose use.[14] Also, there were associations of insulin levels with waist circumference and weight.

Experimental studies on the evaluation of muscle fiber in conditions of IR were not found. In previous studies[15,18] about diabetes and muscle action, morphological changes were observed in striated muscle fibers type I (slow) and II (fast) of the urethra.[15] The microscopic changes in the urethral sphincter of rats include thinning, atrophy, disorganization, and disruption associated with the loss of normal anatomical location of fast and slow muscle fibers, in addition to a lower percentage of fast fibers.[15–18] These data suggest that untreated cases of IR may lead to increased impairment of the PFMs.

Table 3 Results of association analysis using the insulin levels as dependent variable

Independent variables	r	B	β	P-value	R²	Adjusted R
Tone (μV)	−0.685*	−0.047	−0.025	0.866	0.759	0.732
MVC (μV)	−0.687*	0.397	−0.270	0.047**		
Weight (kg)	0.637*	−0.168	−0.414	0.017**		
BMI (kg/m²)	0.613*	−0.067	−0.064	0.601		
Waist circumference (cm)	0.839*	0.490	1.024	0.000**		

Notes: *Significant difference with $P<0.05$ using Pearson correlation (R); **significant difference with $P<0.05$ using linear regression (R²) models.
Abbreviations: BMI, body mass index; MVC, maximal voluntary contraction.

Therefore, IR should be identified and treated early to prevent its progression to diabetes and onset of other clinical disorders including urinary incontinence. Several studies have indicated that the risk of UI is 50%–200% higher among women with type 2 diabetes mellitus compared with that among women with normal glucose levels. Atrophy of the external urethral sphincter was observed in female rats after 20 weeks of diabetes induction.[18–20] It is possible that the larger number of UIs in diabetes mellitus could be explained by PFM disorder.

To date, no study has correlated the strength or electromyographic activity of the PFMs with IR. EMG is now widely used for the evaluation of the PFMs and investigation of neuromuscular disorders. Furthermore, this method has higher interobserver reproducibility in the evaluation of the MVCs and PFM tone in healthy women.[21,22] EMG can detect the electrical activity triggered by the recruitment of motor units but does not measure muscle strength. However, Vodusek has reported a good correlation between the number of activated motor units and muscle strength.[23]

This study has some limitations. The small number of patients in each group is due to the inclusion criteria, established to homogenize the group and avoid bias in electromyographic data. However, no negative interference occurred as a result of the small confidence intervals, and data distribution was normal. Another limitation is the kind of study. The results should be interpreted as indicating an association, and no temporal link can be established.

Conclusion

The results showed that women with IR present worse electromyographic activity than women without IR. In addition, there was an association between high insulin levels and electromyographic signals of the PFMs. It is suggested that IR can affect the PFMs.

Disclosure

The authors report no conflicts of interest in this work.

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