EVALUATION OF ANGULAR SAGITTAL BALANCE IN OBESE PATIENTS

AVALIAÇÃO ANGULAR DO EQUILÍBRIO SAGITAL EM PACIENTES OBESOS

EVALUACIÓN ANGULAR DEL EQUILIBRIO SAGITAL EN PACIENTES OBESOS

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ABSTRACT

Objectives: Given the small amount of information regarding the pathological and degenerative changes of the spine, this study was carried out in order to evaluate and quantify the angular values of sagittal balance in the obese population. Methods: We measured the angles of pelvic incidence (PI), pelvic version (PV) and sacral slope (SS). Results: We evaluated 30 patients, 19 females and 11 males, in 2012, who were to be submitted tobariatric surgery. The mean age was 33 years old. The mean BMI was 41 kg/m2, the mean value for men being 43 kg/m2 and 39 kg/m2 for women. The mean PI was 57°. The PV was 19°. The DS was 38°. The value of pelvic incidence and pelvic version was on average higher than those found in people with normal body mass index. Regarding the sacral slope the value were the same of those of the normal population. Conclusions: Increasingly the sagittal balance has gained importance in the evaluation of the spine. It is necessary further literature and increasing medical knowledge of diseases and comorbidities that may alter sagittal balance in patients, such as obesity.

Keywords: Obesity; Postural balance; Posture; Pelvis; Body mass index.

RESUMO

Objetivo: Tendo em vista a pouca quantidade de informações a respeito das alterações degenerativas e patológicas da coluna vertebral realizou-se este estudo com objetivo de avaliar e quantificar os valores angulares do equilíbrio sagital na população obesa. Métodos: Foram medidos os ângulos de incidência pélvica (IP), versão pélvica (VP) e declive sacral (DS). Resultados: Foram avaliados 30 pacientes, sendo 19 do sexo feminino e 11 do sexo masculino, no ano de 2012 que aguardavam realização de cirurgia bariátrica. A média de idade foi de 33 anos. O IMC médio foi de 41 kg/m², sendo que o valor médio para os homens foi de 43 kg/m² e das mulheres 39 kg/m². O IP médio foi de 57°. O VP foi de 19°. O DS foi de 38°. O valor da incidência pélvica e da versão pélvica ficou em média acima do encontrado na população com índice de massa corporal normal. Já o valor do declive sacral encontra-se na média da população. Conclusões: Cada vez mais o equilíbrio sagital vem ganhando espaço na avaliação da coluna vertebral. Faz-se necessário literatura mais vasta e aumento do conhecimento médico das patologias e comorbidades que podem alterar o equilíbrio sagital em seus pacientes, como a obesidade.

Descritores: Obesidade; Equilíbrio postural; Postura; Pelve; Índice de massa corporal.

RESUMEN

Objetivo: Dada la pequeña cantidad de informaciones con respecto a las alteraciones degenerativas y patológicas de la columna vertebral, se llevó a cabo este estudio con el fin de evaluar y cuantificar los valores angulares de equilibrio sagital en la población obesa. Métodos: Se midieron los ángulos de incidencia pélvica (IP), la versión de la pelvis (VP) y la pendiente del sacro (DS). Resultados: Se evaluaron 30 pacientes, 19 mujeres y 11 hombres, en el año 2012, en fase preoperatoria para la cirugía bariátrica. El promedio de edad fue 33 años. El promedio del IMC fue 41 kg/m2, y el valor promedio de los hombres fue 43 kg/m2 y 39 kg/m2 para las mujeres. El promedio de IP fue 57°. El VP fue 19°. El DS fue 38°. Los valores de la incidencia de la pelvis y de la versión pélvica fueron en promedio mayores que los encontrados en personas con índice de masa corporal normal. Ya el valor de la pendiente del sacro está en el promedio de la población. Conclusiones: Cada vez más, el equilibrio sagital viene ganando importancia en la evaluación de la columna vertebral. Es necesaria más literatura y aumentar el conocimiento médico de las enfermedades y las comorbilidades que pueden alterar el equilibrio sagital en sus pacientes, como la obesidad.

Descriptores: Obesidad; Equilibrio postural; Postura; Pelvis; Índice de masa corporal.

INTRODUCTION

Obesity is a chronic, multifactorial disease that can be considered epidemic. It is associated with a high morbidity and mortality. It is characterized by absolute or relative excess of body fat resulting from an imbalance of the metabolic intake.[1]

According to the World Health Organization (WHO), in 2005 there were approximately 1.6 billion adults and 20 million children under five who were overweight worldwide, and at least 400 million obese adults. The WHO estimates that in 2015 there will be approximately 2.3 billion overweight adults and over 700 million with obesity.[2]

Being overweight affects almost the entire organism and can lead to numerous complications, including degenerative orthopedic and spine diseases.[1,3]

The most recommended way to evaluate body weight is through the Body Mass Index (BMI), which is calculated by dividing body weight (in kilograms) by the square of height (in meters),[4] which is expressed mathematically by the formula: BMI = kg/m^2.

Since obesity is a chronic medical condition with a multifactorial etiology, the treatment involves several approaches such as nutrition, medications, and exercise. In certain cases, when there is not a good response to these treatments, surgical treatment is indicated. Thus, bariatric surgery has been used increasingly, and has shown itself to be a very helpful technique in the clinical management of some cases of obesity.[5] Class III obese patients (BMI above 40 kg/m^2) or class II obese (BMI 35-39.9 kg/m^2) with diseases associated with being overweight, such as type II diabetes, hypertension, and obstructive sleep apnea syndrome, among others, are candidates for this type of intervention, according to the North American National Institute of Health.[6]

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The distribution of central or peripheral body fat directly interferes with body alignment for obese patients, leading to overload and predisposing the onset of postural deviations.[7] Under the influence of biomechanical imbalance caused by the accumulation of fat in the abdomen (central obesity), muscle atrophy can occur, associated with delayed activation of the stabilizing muscles of the spine, thus contributing to the onset of lumbar instability in the obese individual.[8] The thought that there may be changes in the sagittal balance of these patients is valid when thinking about these changes in obese patients. Mainly because it is still a topic that is unknown to the vast majority of orthopedic doctors and even specialists in diseases of the spine.

The study of spino-pelvic sagittal balance came into vogue through studies of diseases that involved spinal deformities. It currently remains a complex subject, and its study has extended to degenerative diseases as well as the prevention of future diseases of the spine.

Despite the alignment of the spine having only been assessed in the coronal plane for many years, several publications highlight the importance of changes in the sagittal plane. The authors also emphasize the relationship of the spine to pelvic orientation changes and how they determine the spinal alignment as a whole.[9-13]

Spino-pelvic sagittal balance is understood to be the relationship between the osteoarticular and myofascial structures of the spinal axis, the pelvis, and lower limbs directly related to postural sway.

The analysis of the sagittal balance of the spine is evaluated by radiographs and angular measurements. Images of the femoral heads should be included in the radiographs, because they allow the understanding of the relationships between the pelvis and the spine of a person. A study by Legaye et al.[14] reported that a close relationship exists between the pelvis and the parameters of the spine.

There is a significant number of studies relating obesity to various diseases; however, there are few studies that include postural and/or osteoarticular changes related to obesity. There is also little understanding of sagittal balance and no specific studies in the obese population. Therefore, it is necessary to carry out further studies in order to describe the main postural changes related to obesity.

Therefore, this study was conducted to evaluate and quantify the angular values of sagittal balance in the obese population.

METHODOLOGY

This is a prospective study conducted from May to December of 2012 at the Hospital de Clínicas, Federal University of Paraná, UFPR, by the Spine Surgery group in conjunction with specialists from the Digestive Surgery and Obesity Surgery of the Dr. Giorgio Baretta Bariatric Surgery Center and Vita Batel Hospital, located in the city of Curitiba. Thirty patients who were being monitored in the clinic for obese patients and who had indications for bariatric surgery according to the criteria of the North American National Institute of Health[6] had their radiologic exams analyzed consecutively. Patients were awaiting bariatric surgery for weight loss.

The inclusion criteria chosen were patients aged 18-60 years, obesity class II (BMI 35-39.9 kg/m^2 with comorbidities) and class III (BMI above 40 kg/m^2).[6] We adopted as exclusion criteria patients who did not grant informed consent, patients with previous surgery in the lumbosacral spine or pelvis, and patients with lower limb dysmetria. No patient was excluded from the study.

All patients had 30 × 90 cm lateral radiographs of the lumbar spine. Radiographs were taken standing with knees extended and arms flexed. The distance of the radiographic film was 230 cm. All radiological parameters were measured by a single author, accustomed to angular measurements of the sagittal balance. The angular variations in lateral radiographs were measured using the techniques described by Duval-Beaupère.[14]

We measured the angles of the pelvic incidence (PI), sacral slope (SS) and pelvic tilt (PT), (Figure 1) and mean angular values and angular changes were obtained.[14]

The angular measurements were compared with normal values for the adult population, these values have already been determined by several authors.[15-19] (Table 1)

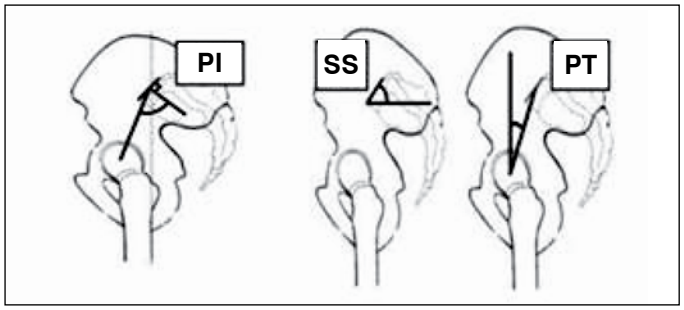

Figure 1. Angles of pelvic incidence (PI), sacral slope (SS) and pelvic tilt (PT), from left to right, respectively.

Table 1. Normal values of the spino-pelvic relationship.

Parameters	Variation in degrees (º)	Mean in degrees (º)
Pelvic incidence (PI)	40 - 65º	51º
Pelvic tilt (PT)	10 - 25º	12º
Sacral slope (SS)	30 - 50º	39º

RESULTS

The average age of the 30 patients included in the study was 33 years (20-55 years), with 83% aged below 40 years. (Table 2)

The majority (63%) were female (19 women), and 11 were men (37%).

The study included 15 class II obese patients and 15 patients with class III obesity. The mean BMI was 41 kg/m^2 (35.1 to 57.3 kg/m^2). If we separate the BMI by degree of obesity, among class II obese patients we have an average of 37 kg/m^2 (35.1 to 38.3 kg/m^2), and among class III obese patients we have an average of 44 kg/m^2 (40 to 57.3 kg/m^2). If we separate BMI by sex, for men we have an average of 43 kg/m^2 (35.5 to 57.3 kg/m^2), and among women, 38 kg/m^2, ranging from 35.1 kg/m^2 to 42.8 kg/m^2.

The mean pelvic incidence value was 57°, ranging from 40 to 75°. Six patients (20%) had a PI greater than 65°, which is higher than what is acceptable for the general population.

The mean pelvic tilt value was 19°, ranging from 10 to 35°, and 10% of these patients had a PT greater than 25 degrees.

The mean sacral slope value was 38° (30 to 55°). Of the thirty patients, only one had a SS greater than 50°, the maximum that is considered normal.[16-20]

Figure 2 shows the distribution of mean PI, PT and SS values.

DISCUSSION

Obesity is a serious and growing health problem that affects millions of people, regardless of geographic location, age, race, educational level, or sex.[20] Many people also suffer from spinal problems. Although often disabling, these two diseases, obesity and spine disease, are not fatal,[21] a fact that resulted in the neglect of these diseases in the past. Currently, the study of and attempt to solve these two problems defy medicine. This study verified the relationship between obesity and sagittal balance, and compared the data obtained with the values of the population with a normal BMI, values that have previously been published.[15-19]

Silva et al.[22] observed a significant linear increase along with the BMI in the prevalence of chronic low back pain in an adult population, and also that the "extra load" that the osteomuscular articular structure is required to sustain can change the biomechanical balance of the body, and thus increase the risk of low back pain in persons with overweight and obesity. Radominski[23] suggests that truncal obesity probably increases the mechanical load on the lumbar spine.

The paucity of previous studies linking obesity and postural

Table 2. Epidemiological data and individual angular values.

Patient	Age	Sex	BMI	BMI Class	PI	PT	SS
1	23	Female	38.3	II	65	25	40
2	28	Female	35.4	II	40	10	30
3	32	Female	35.3	II	50	10	40
4	30	Male	40	III	60	25	35
5	26	Female	35.1	II	50	10	40
6	25	Female	40.3	III	55	25	30
7	31	Male	48.7	III	70	20	50
8	55	Male	48.3	III	75	35	40
9	34	Female	38	II	60	25	35
10	38	Female	42.4	III	50	15	35
11	38	Male	38	II	60	20	40
12	47	Female	41.4	III	60	20	40
13	34	Male	46.5	III	45	20	25
14	45	Female	42.8	III	75	30	45
15	34	Male	35.5	II	75	25	50
16	37	Female	36	II	45	10	35
17	29	Female	35.3	II	60	20	40
18	33	Female	41.1	III	50	20	30
19	23	Male	43.2	III	65	30	35
20	37	Female	37.8	II	50	20	30
21	20	Female	38	II	40	10	30
22	30	Female	41.1	III	70	15	55
23	31	Female	40	III	50	10	40
24	38	Female	37.7	II	50	10	40
25	28	Male	42.1	III	70	25	45
26	40	Male	57.3	III	40	10	30
27	28	Male	40.3	III	60	20	40
28	28	Male	36.1	II	55	15	40
29	42	Female	36.3	II	50	20	30
30	33	Female	38.3	II	50	15	35

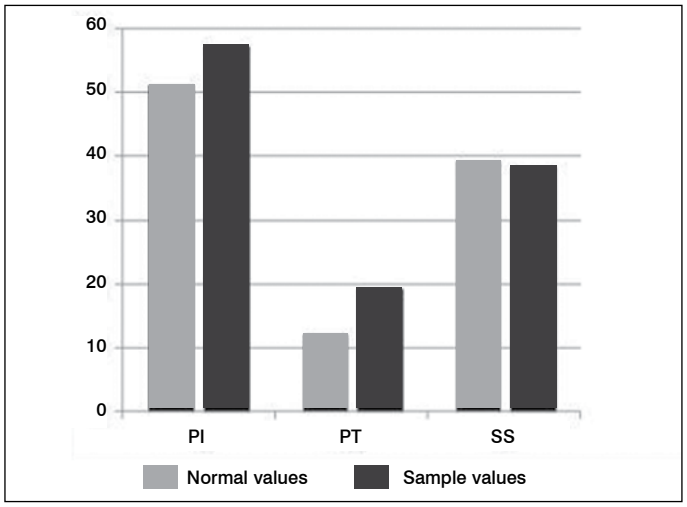

Figure 2. Comparison of the mean values of pelvic incidence (PI), pelvic tilt (PT) and sacral slope (SS) of the sample with the population with a normal BMI.

change and sagittal balance gave rise to the idea of starting a line of research in obese patients. This study is the initial phase and contains the first data. In the future, the intention is to compare the preoperative sagittal balance of these patients (state in which they are currently) with it post-bariatric surgery, about six months after the completion of surgery, estimated as the peak of weight loss. The expectation is that there is an improvement in the angular parameters and possible improvements in the alignment of the lumbar spine after weight loss.

In the present study, the division between obesity class II and class III was similar, with 15 patients in each group. There was a higher prevalence of females, who accounted for about 63% of the sample. Even though outnumbered, the male patients had a greater BMI than the female group; the mean BMI of the men was 43 kg/m^2 (35.5 to 57.3 kg/m^2) and that of the women, 38 kg/m^2 (35.1 to 42.8 kg/m^2). This may have occurred because the female patients take greater care of their bodies and worry about their aesthetic component, and are more concerned with their quality of life, which will lead them to seek treatment earlier than men. The average age was 33 years (20-55 years), a fact that leads us to the food and behavioral quality of the modern day. The age group studied was a fairly young group, in which one expects to find physical vigor and good quality of life. This is a disturbing fact that deserves attention regarding dietary habits and early physical rehabilitation.

Results from Fanuele et al.[24] showed that obese patients with low back pain are more deficient in general, have more severe low back pain, have more comorbidities than non-obese patients, and that BMI is a significant predictor of functional health status.

With regard to the balance parameters, Legaye et al.[25] studied that the pelvic incidence and sacral slope are fundamental angles to the understanding of sagittal balance and lumbar lordosis.

We can define, for teaching purposes, an angle of 51 degrees as the average adult pelvic incidence in the asymptomatic population.[26,27]

In the present study we obtained an average pelvic incidence of 57 degrees, above that of the population with a normal BMI. Taking into account the normal variation of 40-65°, we also observed that the sample showed above normal variation, ranging from 40 to 75 degrees. Six patients presented a PI value above the value considered to be the maximum for normal. Of these six patients, five (83%) had a BMI greater than 41 kg/m^2. We can infer that the highest pelvic incidence rates were in patients with the highest BMI. With a higher pelvic incidence, obesity can lead to premature degeneration of the lumbosacral spine, which can behave like an intrinsic spinal pathology, such as spondylolisthesis, which is widely studied in relation to sagittal balance.

Duval-Beaupère and Robain demonstrated that pelvic incidence is an important anatomical parameter that describes the anatomical shape of the pelvis and influences the configuration of the position of the spine and pelvis, and therefore of the sagittal balance. Many studies[28,29] have suggested that sagittal balance is a combination of balance between the spino-pelvic shape and position parameters, which are interrelated. The shape of the pelvis is best quantified by the pelvic incidence, which determines the position of the pelvis and sacrum. The spine is related to adjustments in lumbar lordosis by increasing the slope of the sacrum in order to balance the back in an upright position.

Pelvic tilt is a parameter of the position of the pelvis, and low values indicate anteversion, more common in relation to standing, and higher values indicate retroversion, more common in relation to the sitting position. The retroversion of the pelvis is a compensatory mechanism of the sagittal imbalance, leading to a posterior center of gravity. High values, greater than 12 degrees, indicate that the pelvis is unbalanced.

In the present study, we found an average value of 19°, ranging from 10° to 35°. Thirteen obese patients class III and nine obese patients class II had a PT value greater than 12°. This evidence shows that the pelvis of obese patients is unbalanced in relation to what would be expected for this population without this comorbidity.

The sacral slope parameter measures the angle of the sacral plateau in relation to the ground. The more horizontal the plateau, the lower the sacral slope. Depending on the position of the sacral plateau, forces can act on the discs and facets. Normal parameters[15-19] range from 30 to 50 degrees. In the present study, there was an average value of 38 degrees, ranging from 30 to 55 degrees, which was not much different from the rest of the population.

An important limitation of the study was the lack of a control group formed by normal people without obesity. Furthermore, there

is a need for a larger number of patients in order to extrapolate these results. The range of the parameters considered to be normal[15-19] is very large, so that most obese patients are in the normal range. As stated earlier, this is an initial study within a line of research and these are the first results obtained.

CONCLUSION

In our series of cases, the pelvic incidence and pelvic tilt proved to be above average in the obese population. The sacral slope value is within the average range of those with a normal BMI. There are no studies linking obesity and sagittal balance. This is an initial study in this evaluation. Further study is necessary in this regard, in order to increase the medical knowledge of conditions and comorbidities that may alter sagittal balance in patients, such as obesity.

All authors declare no potential conflict of interest concerning this article.

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