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## Original Article

# Evaluation of spinopelvic balance among patients undergoing surgical treatment for lumbar disk hernia<sup>☆</sup>

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## ABSTRACT

**Objective:** to evaluate spinopelvic balance using the pelvic incidence, sacral slope and pelvic tilt among patients with lumbar disk hernias who underwent surgical treatment.

**Methods:** thirty patients at the spinal services of Hospital Santa Casa de Misericórdia de Vitória and Hospital Vila Velha were evaluated by measuring their spinopelvic balance from the angles of pelvic tilt, sacral slope and pelvic incidence, with their respective means, on simple lateral-view lumbopelvic radiographs that needed to encompass the lumbar spine, sacrum and proximal third of the femur.

**Results:** the spinopelvic balance measurements obtained from the mean angles of the population studied, for pelvic incidence, sacral slope and pelvic tilt, were 45°, 36.9° and 8.1°, respectively. The confidence interval for the mean pelvic incidence was from 41.9 to 48.1 (95% CI), thus including a reference value that characterized it as low, for an asymptomatic population, thus confirming that the sample was extracted from a population with this characteristic.

**Conclusion:** among these patients with lumbar disk hernias who underwent surgical treatment, the average spinopelvic balance was found to have pelvic incidence lower than what has been reported in the literature for an asymptomatic population.

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<sup>☆☆</sup> Work performed at the Vertebral Column Service, Hospital Santa Casa de Misericórdia de Vitória, Vitória, ES, Brazil.

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## Avaliação do equilíbrio espinopélvico em pacientes submetidos a tratamento cirúrgico de hérnia de disco lombar

### R E S U M O

#### Palavras-chave:

Deslocamento do disco intervertebral  
Coluna vertebral  
Disco intervertebral

**Objetivo:** avaliar o equilíbrio espinopélvico, por meio da incidência pélvica, do declive sacral e da versão pélvica, em pacientes portadores de hérnias discais lombares submetidos a tratamento cirúrgico.

**Métodos:** foram avaliados 30 pacientes do Serviço de Coluna Vertebral do Hospital Santa Casa de Misericórdia de Vitória e do Vila Velha Hospital, por meio da aferição do equilíbrio espinopélvico, obtido pela mensuração dos ângulos da versão pélvica, do declive sacral e da incidência pélvica, com suas respectivas médias, nas radiografias simples lombopélvicas, tipo perfil, que englobaram, obrigatoriamente, coluna lombar, sacro e terço proximal do fêmur.

**Resultados:** a medida do equilíbrio espinopélvico, obtida pela média dos ângulos na população estudada da incidência pélvica, do declive sacral e da versão pélvica, foi de 45°, 36,9° e 8,1°, respectivamente. O intervalo de confiança da média da incidência pélvica entre 41,9 - 48,1 (95% IC) contém o valor de referência que a caracteriza como baixa, para uma população assintomática, o que confirma que a amostra foi extraída de uma população com essa característica.

**Conclusão:** nos pacientes portadores de hérnia discal lombar submetidos a tratamento cirúrgico foi encontrado, em média, um equilíbrio espinopélvico com incidência pélvica abaixo do encontrado na literatura para uma população assintomática.

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## Introduction

Disk hernias are defined as a continuous process of disk degeneration that causes migration of the nucleus pulposus beyond the physiological limits of the fibrous ring.<sup>1</sup> Lumbar hernias occur most frequently and mainly affect men in the age group from 30 to 50 years, in the segments L4-L5 and L5-S1. Because of the epidemiological importance of this disease, it is considered to be a worldwide health problem, given the physical and functional incapacity that it may cause.<sup>1-4</sup>

The etiology of disk hernias is multifactorial, through associations of degenerative disk alterations that cause decreases in proteoglycan content in the nucleus pulposus, in situations in which there is an increase in disk pressure, especially due to rotation and flexion of the spine. Despite this knowledge of the multifactorial nature of disk hernias, better definition of their etiological origin has been sought because, through this, measures can be taken with the aim of preventing or diminishing the consequent disorders that this condition creates.<sup>1,2</sup>

Over recent years, the spinopelvic balance between osteoarticular and neuromyofascial elements of the structure of the spine, pelvis and lower limbs has gained prominence with regard to the genesis of various pathological conditions of the spine. An association between disk hernias and the spinopelvic system has been observed.<sup>5-18</sup>

Through this greater knowledge of the spinopelvic balance, we have attempted to evaluate and use the pelvic incidence, sacral slope and pelvic tilt and their correlation with patients presenting lumbar disk hernias in order to identify patients with a tendency to develop this condition. In this manner, we

aimed to refine strategies for prevention and adequate prognosis for this population.

## Materials and methods

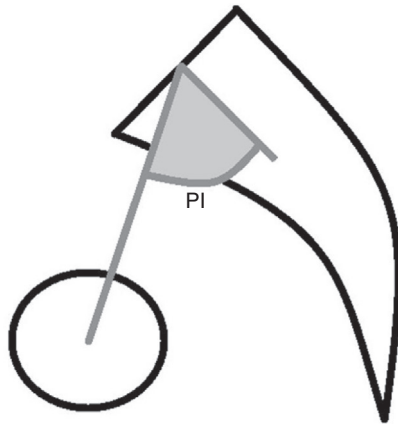
This was a retrospective study that was approved by the Research Ethics Committee under the number 04993212.3.0000.5065. In this study, 30 patients attended at the Spinal Service of Hospital Santa Casa de Misericórdia de Vitória and Vila Velha Hospital were evaluated (21 men; age range: 18-62 years).

The inclusion criteria were that the patients needed to present a lumbar disk hernia with an indication for surgery, and needed to have undergone a minimum of 20 physiotherapy sessions without improvement, but without presenting any criteria of instability on dynamic radiographs.

Patients were excluded from the study if they did not present an indication for surgical treatment using the microdiscectomy technique, and also if they achieved improvement through physiotherapy or were found to present criteria of instability on preoperative radiographs of the lumbar spine.

The spinopelvic balance was measured using the angles of pelvic incidence, sacral slope and pelvic tilt on simple lumbopelvic radiographs in lateral view. These radiographs needed to encompass the lumbar spine, sacrum and proximal third of the femur.

The angles on the radiographs were measured manually and the pelvic incidence was obtained from the angle formed on sagittal radiographs by a line perpendicular to the sacral plateau, going from its midpoint, and a line joining the center of the sacral plateau to the midpoint of the segment joining



**Fig. 1 – Illustration of pelvic incidence (PI).**

the two centers of the femoral heads, which is known as the bicoxofemoral axis (Fig. 1).

The sacral slope consists of the intersection between a horizontal line that follows the ground and a line that follows the sacral plateau. The pelvic tilt consists of the intersection of a vertical line, perpendicular to the ground, with a line joining the bicoxofemoral axis to the center of the sacral plateau (Fig. 2). It is known that the sum of the angles of the pelvic tilt and sacral slope equals the value of the pelvic incidence.

The frequencies were analyzed with 95% confidence intervals (95% CI; Taylor series). The results were represented numerically by means of absolute values, and some data were also expressed as percentages. The Kolmogorov-Smirnov test was applied in order to ascertain whether the distribution of probabilities of the data was normal: this hypothesis was accepted. Student's t test was applied to make comparisons between the means of the variables. The data analysis was done using the Microsoft Office/Excel 2007 software.

## Results

Thirty patients were evaluated. There were 21 men of ages ranging from 18 to 58 years (mean of 40 years) and nine

women of ages ranging from 18 to 62 years (mean of 33 years).

The spinopelvic balance was measured from the pelvic incidence, sacral slope and pelvic tilt, and the mean values found were 45°, 36.9° and 8.1°, respectively. The distribution of the parameters observed can be seen in Fig. 3.

From Student's t test, there was no significant difference in the means for the parameters studied between individuals of different sexes, as shown in Fig. 4. The descriptive levels were  $p = 0.206$ ,  $p = 0.622$  and  $p = 0.411$  for the parameters of the sacral slope, pelvic tilt and pelvic incidence.

From specific analysis on the pelvic incidence, we observed that its mean value in our study was 45° and it presented a confidence interval from 41.9° to 48.1° (minimum and maximum values, respectively). The mean values for slope and tilt were 36.9° and 8.1°, with a confidence interval as described in Table 1.<sup>5,7,8,10,12,13,17</sup>

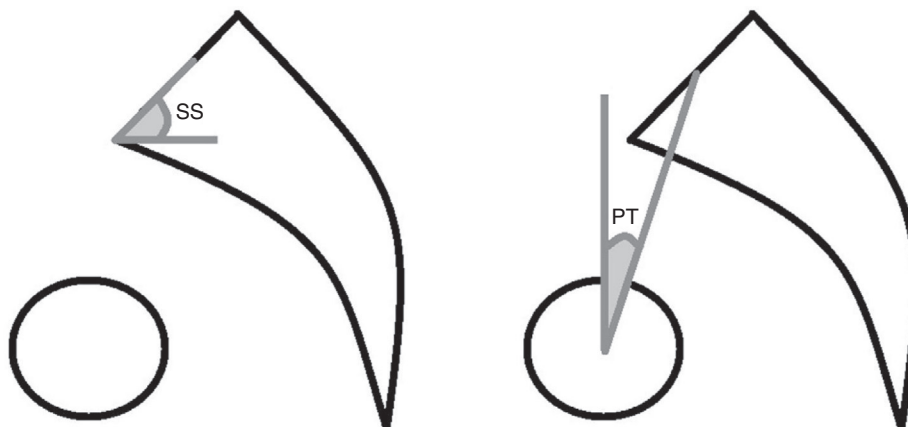
## Discussion

Several studies on spinopelvic balance and diseases of the spine have been developed with the aim of better understanding what its relationship with the human body is. Its importance is such that Roussouly et al.,<sup>9</sup> in 2003, classified lumbar lordosis into four morphological patterns, taking the angle of the sacral slope as the reference.<sup>6,9,11-13,15</sup>

The main radiological parameters used for evaluating the spinopelvic balance are the pelvic incidence, sacral slope, pelvic tilt and lumbar lordosis. The first of these is an individual anatomical constant and the others are variable, according to the posture adopted. The pelvic incidence, which was studied by Legaye et al.<sup>7</sup> in 1998, was the result from summing the angles of sacral slope and pelvic tilt. The pelvic incidence was a fundamental angle for comprehending this balance.<sup>6-15</sup>

In our study, we sought to identify what the pelvic incidence, sacral slope and pelvic tilt values were, in patients with lumbar disk hernias who underwent simple microdiscectomy. We took the view that better understanding of the spinopelvic balance in these patients might influence the type of surgery and preventive actions relating to disk hernias.

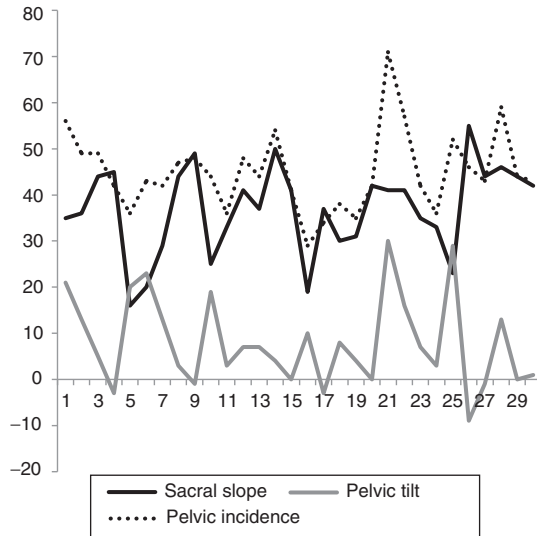
The mean pelvic incidence in the asymptomatic population ranges from 52° to 55°, according to the references



**Fig. 2 – Illustration of sacral slope (SS) and pelvic tilt (PT).**

**Table 1 – Statistics on the parameters observed.**

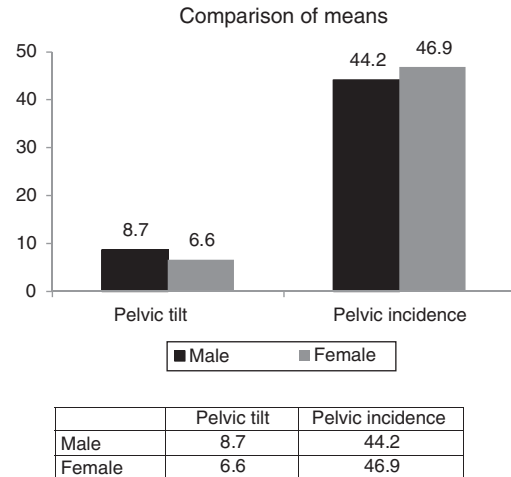
	Minimum	Maximum	Mean	Standard deviation	95.0% CI
Sacral slope	16	55	36.9	9.6	(33.5; 40.3)
Pelvic tilt	-9	30	8.1	9.7	(4.6; 11.6)
Pelvic incidence	29	71	45	8.6	(41.9; 48.1)



Sex	Sacral slope	Pelvic tilt	Pelvic incidence
Male	35	21	56
Male	36	13	49
Male	44	5	49
Male	45	-3	42
Male	16	20	36
Male	20	23	43
Male	29	13	42
Male	44	3	47
Male	49	-1	48
Male	25	19	44
Male	33	3	36
Male	41	7	48
Male	37	7	44
Male	50	4	54
Male	41	0	41
Male	19	10	29
Male	37	-3	34
Male	30	8	38
Male	31	4	35
Male	42	0	42
Male	41	30	71
Female	41	16	57
Female	35	7	42
Female	33	3	36
Female	23	29	52
Female	55	-9	46
Female	44	-1	43
Female	46	13	59
Female	44	0	44
Female	42	1	43

**Fig. 3 – Distribution of the parameters observed.**

that we analyzed. In our study, the mean value for pelvic incidence among our patients was 45°. In analyzing the confidence interval, we observed that there was a variation of ±3.1° (95% CI: 41.9-48.1), which suggests that patients with lumbar disk hernias who do not present any improvement through physiotherapy and need surgical treatment have a



**Fig. 4 – Comparison of the means for the parameters between the sexes.**

pelvic incidence lower than what is found in the asymptomatic population.<sup>5,7,8,10,12,13,17</sup>

The pelvic incidence is a constant angle that is geometrically equivalent to the sum of the angular measurements of the pelvic tilt and sacral slope, which can vary according to the patient's positioning. In analyzing the mean values for the slope and tilt from our study in relation to those in the literature, we observed that there were large discrepancies in the measurements, which were not uniform between all the studies analyzed. This can possibly be explained by the methodology used in each study for positioning the patient at the time of the radiological examination.<sup>5,7,10,12</sup>

### Conclusion

Patients with lumbar disk hernias present spinopelvic equilibrium with low pelvic incidence, compared with the asymptomatic population. These patients seem to have an additional risk factor that influences the etiology of lumbar disk hernias, because of greater pressure occurring at the level of the intervertebral disk, especially in the segments L4-L5 and L5-S1.

We consider that further studies on the correlation between spinopelvic balance and lumbar disk hernias are necessary. We believe that this parameter should be fully analyzed before patients with disk hernias are treated.

### Conflicts of interest

The authors declare no conflicts of interest.

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