

## RESEARCH ARTICLE

## Correlation between Sagittal Spinopelvic Parameters and Oswestry Disability Index after Thoracal and Lumbar Spine Stabilization and Fusion

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### Abstract

Spinopelvic parameter consists of sagittal vertical axis (SVA), pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS) which are measured by whole-spine-lateral-view radiograph in standing position. Measurement of the separameters is pivotas the land mark analysis toachieve correct sagittal balance. The objective of the study is to analyze the correlation between PI, PT, SVA and SS with the clinical outcomes which was measured using Oswestry Disability Index (ODI) scoring system. This is a cross-sectional study involving 19 patients who underwent thoracal and lumbar fusion surgery in our center during 2012-2014. Radiographi cevaluation of SVA, PI, PT, and SS and ODI score were performed 1 year after surgery. Pearson test was conducted to determine the correlation between SVA, PI, PT, and SS with ODI score. There was a strong correlation between ODI with SVA and PI ( $p < 0.001$ ,  $r = 0.866$ ;  $p = 0.006$ ;  $r = 0.603$ , respectively). There was no correlation between other parameters with ODI. Based on this study, spinopelvic parameters that can represent the clinical outcome after thoracal and lumbar fusion and stabilization surgeries are SVA and PI.

**Keywords:** spinopelvic parameter, post operation, vertebrae fusion.

## Korelasi antara Parameter Luaran Spinopelvik Sagital dengan Oswestry Disability Index pasca Stabilisasi dan Fusi Vertebra Torakal dan Lumbar

### Abstrak

Parameter spinopelvis terdiri atas sagittal vertical axis (SVA), pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS) dan diukur menggunakan X-ray seluruh tulang belakang lateral yang diambil pada posisi berdiri. Pengukuran parameter ini penting sebagai dasar analisis keseimbangan sagital pada operasi rekonstruksi vertebra. Tujuan penelitian ini adalah untuk menganalisis korelasi antara PI, PT, SVA, dan SS pada luaran klinis berdasarkan sistem skoring oswestry disability index (ODI). Studi ini adalah studi potong lintang dengan 19 subjek yang menjalani fusi dan stabilisasi torakal dan lumbal di center kami dalam periode 2012-2014. Evaluasi radiografi dari SVA, PI, PT, dan SS serta penilaian skor ODI dilakukan 1 tahun setelah operasi. Uji Pearson dilakukan untuk mencari korelasi antara SVA, PI, PT, SS dengan skor ODI. Ditemukan adanya korelasi kuat antara ODI dengan SVA ( $p < 0.001$ ;  $r = 0.866$ ) serta ODI dan PI ( $p = 0.006$ ;  $r = 0.603$ ). Tidak ditemukan korelasi antara ODI dengan PT dan SS. Berdasarkan studi ini, parameter spinopelvis berupa SVA dan PI dapat menunjukkan luaran klinis pasca fusi dan stabilisasi pada torakal dan lumbal.

**Kata kunci:** parameter spinopelvis, post operasi, fusi vertebra

## Introduction

In the sagittal plane, several measurements have been described to evaluate the balance between the spine and the pelvis. Each measurement was created to elaborate the shape and orientation of each anatomical segment which is closely related to each other to be able to maintain a stable posture with minimal energy expenditure. Changes in the orientation or the shape of a certain segment will have an impact to the adjacent segment.<sup>1,2</sup> The normal and stable orientation of spinopelvic region may be impaired in some conditions such as lumbar spondylosis, spondylolisthesis, spinal deformity, and degenerative intervertebral disc disease.<sup>1</sup>

Spinopelvic parameters are used to determine the balance between spine with lower extremity in sagittal plane. These parameters consist of sagittal vertical axis (SVA), pelvic incidence (PI), pelvic tilt (PT), and sacral slope (SS).<sup>1</sup> Spinopelvic parameters allow us to evaluate the existing disability in patients with spinal disorders.<sup>1,2</sup> Schwab et al.<sup>2</sup> have reported a strong correlation between retroverted pelvis (measured using pelvic tilt) and SVA with health related quality of life (HRQoL) score.<sup>2</sup> A study by Min Ah, et al.<sup>3</sup> showed that PI and SS were significantly higher in patients with lumbar spondylosis. Meanwhile, SVA and PT was higher in patients with symptomatic degenerative of spondylolisthesis compared with asymptomatic ones.<sup>3</sup>

Kim, et al.<sup>4</sup> suggested that there was a correlation between the improvement of PT with clinical improvement in degenerative spondylolisthesis patients that underwent posterior fusion procedure. Measurement of the specific functional conditions is often used in clinical trials to evaluate the patient's clinical improvement. Experts mentioned that in performing clinical measurements for low back pain cases, it is advisable to use a standardized method, such as Oswestry Disability Index (ODI) or Roland-Morris disability questionnaire. Both assessment methods have been widely used in various situations and are available in multiple languages.<sup>5</sup>

In Indonesia, there was no research that evaluated the correlation between spinopelvic parameters and the clinical outcomes, particularly the ODI. This aim of this study was to evaluate the relationship between the spinopelvic parameter with the ODI of the patients that had undergone thoracic and lumbar spine stabilization and fusion.

## Methods

This is a cross-sectional study. All subjects were patients who underwent spinal fusion surgery by one senior orthopaedic spine surgeon during January 2012 - December 2014. Spinopelvic parameters (SVA, SS, PT, and PI) were evaluated from the lateral view of the erect whole-spine radiograph. Meanwhile, clinical outcome was assessed using ODI questionnaire in outpatient clinic. These data then were analysed using Pearson Correlation analysis to determine their correlation.

## Results

There were 19 patients who underwent posterior spinal fusion surgery and routinely visit the outpatient spine clinic in January 2012-December 2014. Twelve women (63.1%) and seven (36.9%) men with mean age of  $44.3 \pm 1.85$  years old were enrolled. Most subjects were diagnosed with degenerative disease (57.8%), followed by infection (36.9%) and trauma (5.3%). Lumbar fusion was performed in 89.4% cases while thoracic fusion was only performed in 10.6%. Average ODI score was  $21.9 \pm 4.35$ .

The correlation between ODI scores and SVA were statistically and clinically significant ( $p < 0.001$ ;  $r = 0.866$ ). Likewise, between ODI and PI, there was a strong correlation that was statistically ( $p = 0.006$ ) and clinically significant ( $r = 0.603$ ). The remaining results were shown in Table 1.

**Table 1. Statistic test summary**

Parameter	p value	r value
ODI vs SVA	<0,001	0,866
ODI vs PI	0,006	0,603
ODI vs PT	0,107	0,382
ODI vs SS	0,051	0,454

Pearson correlation

## Discussion

From 147 patients who have undergone posterior stabilization and fusion from January 2012 until December 2014, only 19 were willing to be included in the research. Most patients refused due to financial problem as spinopelvic measurement radiograph were not covered by national health insurance, hence the cost had to be paid by patients themselves.

Hikata et al<sup>6</sup> evaluated the relationship between spinopelvic parameters and improvements in clinical outcomes and quality of life in patients with lumbar canal stenosis who underwent lumbar spinal decompression surgery. In that study, patients with post-decompression lumbar canal stenosis showed a negative relationship between the quality of life and health status with the amount of post operative residual sagittal imbalance.

In this study, the objective was to evaluate the correlation between spinopelvic parameters with the clinical outcome measured using ODI score. There was a positive correlation between ODI and SVA with p value of <0.001 and  $r=0.866$ . We also found a correlation between ODI and PI by using the Pearson test (p value of 0.006;  $r=0.603$ ). This is consistent with a study by Schwab et al<sup>7</sup> in the analysis of the relationship between spinopelvic parameters and disability status of adult spinal deformity patients. A total of 492 adult patients with spinal deformity were involved in their study. Measurement of SVA, PT, PI, and lumbar lordosis angles were performed. Disability status was measured with ODI, Scoliosis Research Society-22R, and the Short Form-12. From this study, it was concluded that SVA, PI and PT could predict the state of disability in patients with spinal deformity.

Research conducted by Smith et al<sup>8</sup> also showed a correlation between ODI with SVA and PI. They evaluate disability status in patients with spinopelvic malalignment who underwent spinal surgery. The patients were divided into two groups, one with compensated spinopelvic malalignment (SVA <5cm and a PI-lumbar lordosis mismatch >10°) and the other with uncompensated spinopelvic malalignment (SVA >5 cm). The clinical outcome was measured with ODI, Short Form-36, and the Scoliosis Research Society-22. The study concluded that elevated SVA correlated with significant disability. However, in normal SVA patients, who complained pain and was disabled, PI and lumbar lordosis must be evaluated since they were the possible source of problem and must be corrected. Surgical corrections in both groups showed similar improvement in radiologic and health related quality of life score.

Lee et al<sup>9</sup> evaluated 138 patients with osteoporosis and 40 control patients. All participants underwent radiographic examination of the spine, measurement of lumbar spinal bone mineral density (LSBMD) and femoral neck bone mineral density (FBMD). Participants also completed a Visual Analogue Scale, ODI score, and the Scoliosis

Research Society questionnaires. The study found there were significant difference between two groups in terms of SVA, SS, PT, and lumbar lordosis. The study also found a statistical correlation between SVA and SS with clinical outcomes.

Different conclusions were shown in a study conducted by Wang et al<sup>10</sup> as they examined the relationship between spinopelvic parameters and clinical symptoms in patients with severe spondylolisthesis. The study involved 64 patients with isthmic spondylolisthesis at the level of L5. The patients were divided into 2 groups based on ODI score (the mild lower back pain and severe lower back pain). The result showed that SVA, SS, and PT had a significant correlation with clinical symptoms. On the other hand, PI was not correlated with clinical symptoms.

Relationship between SVA and PI with ODI score was also shown by a study conducted by Rajnics, et al<sup>11</sup> which evaluated pelvic anatomy in patients with lumbar disc herniation and its comparison with normal individuals. Patients with lumbar disc herniation had a relatively straight spine in the sagittal plane, and the sacrum tended to be vertical. This position will lead to a greater gravitational pressure in the axial axis, which caused progressive degeneration of the intervertebral discs. When the position of the lumbar spine tends to deviate anteriorly, as in patients with positive SVA, it resulted in spinopelvic instability and greater contraction of the muscles of the spine to re-balance the spatial relationship between the affected vertebrae and pelvis which would lead to back pain.

In addition of back pain, high PI values would increase the risk of hip osteoarthritis. This was stated by Yoshimoto et al<sup>12</sup> in his research about spinopelvic parameters in hip osteoarthritis and low back pain patients. The study involved 150 patients with hip osteoarthritis and 150 patients with low back pain. SVA, PI, PT, SS, and lumbar lordosis were measured and compared between these two groups. The result showed that there were significantly higher PI values in the patients with osteoarthritis of the hip.

In his study, Lazanec et al<sup>13</sup> performed radiographic analysis of the spine before and after lumbosacral fusion to evaluate the effect of collinear arrangement of spinal fusion with occurrence of postoperative pain or failed spinal surgery. In patients with pain after fusion, PT measurements showed a doubled value, with a low SS numbers. This indicated that the sacrum remained in the vertical condition.

This study also evaluated whether pre-operative spinopelvic parameters was able to predict the outcome of the operation. Group of patients with low back pain after surgery had large PT and low SS.

One of the shortcomings of this study was the low participation rate, thus it might not represent all patients who underwent spinal fusion surgery in our hospital. However, since the result showed similar outcome with previous studies, this study may add valuable information for spinal deformity cases. Some differences in the result may be caused by different study population. A large study with different subgroups based on different surgical indication with a set of normal control group is needed to prove the study result and compare between different etiology of spinal deformity.

### Conclusion

Spinopelvic parameters PI and SVA have a significant correlation with the clinical outcomes of patients after spinal fusion. Spinopelvic parameters PT and SS do not correlate with clinical outcomes of patients after spinal fusion. Good PI angle and SVA distance is needed to achieve good clinical outcomes in patients undergoing spinal fusion and stabilization of the thoracic and lumbar. Hence, before performing surgery, measurement of PI and SVA should be performed to predict the prognosis of the patients and correct the deformity if considered necessary. It also may alter clinical pathway in patients with spinal deformity, where whole sagittal spine radiograph should be performed and covered by national health insurance.

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