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Clinical and radiological outcome analysis among patients with spondylitis tuberculosis of the lumbar vertebrae after correction and posterior instrumentation in cipto mangunkusumo and Fatmawati Hospital in 2018–2020: A cross sectional study

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ABSTRACT

Introduction: Spondylitis tuberculosis can cause changes in spinopelvic parameters including pelvic incidence, pelvic tilt, and sacral slope due to biomechanical changes of the spine. Posterior instrumentation is one of the modality for the treatment of spondylitis tuberculosis. However, in Indonesia, clinical and radiological outcomes after posterior instrumentation in tuberculosis of lumbar vertebrae are still rare. This study aims to investigate the clinical and radiological outcomes of patients with spondylitis tuberculosis of the lumbar vertebrae after posterior instrumentation.
Method: This study was a cross-sectional study in patients with spondylitis tuberculosis of the lumbar vertebrae who underwent posterior instrumentation in Cipto Mangunsukumo and Fatmawati Hospital. Subjects were collected through consecutive sampling. 23 subjects were collected and analyzed. Clinical and radiological outcomes before and after posterior instrumentation were compared. The clinical outcome included the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI). The radiological outcome included sacral slope, pelvic tilt, pelvic incidence, and lumbar lordosis.
Results: The median age of the subjects was 31 (9–57) years with a female-majority (60,9%). The median of the total vertebral infected was 2 (1–4). Median of VAS score before surgery, 6 months after surgery, and 12 months after surgery were 9 (4–10), 4 (1–7), dan 2 (1–6) ($p < 0{,}001$) consecutively. Median of ODI score before surgery, 6 months after surgery, and 12 months after surgery were 70 (40–86), 34 (10–74), dan 12 (2–74) ($p < 0{,}001$) consecutively. There was no significant difference in spinopelvic parameters before and after the surgery. The difference of ODI score before and after the surgery inversely correlated with the difference of lumbar lordotic and sacral slope.
Conclusion: Posterior instrumentation could improve clinical outcomes in patients with spondylitis tuberculosis of the lumbar. Change of lumbar lordotic and sacral slope after posterior instrumentation led to an improvement of quality of life marked by the reduction of the ODI score.

1. Background

Spondylitis tuberculosis is an infection of the vertebrae caused by Mycobacterium tuberculosis. Tuberculosis infection is more often found in developing countries. The tuberculosis rate was 30 million people in 2011. Globally, TB incidence in 2011 reached 8.7 million. As much as 59% of the incidence rate came from Asia and 26% from Africa. Spinal involvement in TB infection occurs in 2–3% of cases [1,2].

Spondylitis tuberculosis can cause changes in spinopelvic parameters including pelvic incidence, pelvic tilt, and sacral slope due to biomechanical changes of the spine. The spinopelvic parameters consisted of PI, PT, and SS which describes the sagittal balance and spinopelvic alignment. It is currently recognized that spinopelvic alignment is an important aspect of maintaining efficient posture in normal conditions

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and certain diseases. Abnormalities on spinopelvic parameters are associated with several spinal conditions [3].

The thoracal and lumbar vertebrae are the most affected segment in spondylitis tuberculosis. Posterior instrumentation is one of the modalities for the treatment of spondylitis tuberculosis. Surgical intervention is indicated in cases with neurological deficit progression, persistent pain due to instability, and severe deformity [4]. Posterior instrumentation is proven to improve local symptoms within one to three weeks postoperatively in patients with tuberculous spondylitis can improve local symptoms within one to three weeks postoperatively without any significant difference compared with the anterior approach in terms of neurological and degree of correction [5]. Posterolateral fusion, stabilization of the affected segments, and spinal alignment were achieved in all of the subjects with posterior instrumentation [5]. Another study by Okada et al. reported superior outcomes with more loss of correction, small and shorter duration of hospitalization in posterior instrumentation compared with surgical technique without instrumentation [6]. Other studies reported improvement of HRQOL and pain control after posterior instrumentation in spondylitis tuberculosis [7,8].

However, in Indonesia, clinical and radiological outcomes after posterior instrumentation in tuberculosis of lumbar vertebrae are still scarce. This study aims to investigate the clinical and radiological outcomes of patients with spondylitis tuberculosis of the lumbar vertebrae after posterior instrumentation.

2. Methods

2.1. Study design

This study was a cross-sectional study in patients with spondylitis tuberculosis of the lumbar vertebrae who underwent posterior instrumentation in Cipto Mangunsukumo or Fatmawati Hospital. This study was conducted between January 2018–July 2020. Clinical and radiological outcomes before and 12 months after posterior instrumentation were compared. The clinical outcome included the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI). The radiological outcome included sacral slope, pelvic tilt, pelvic incidence, and lumbar lordosis. This research paper is fully compliant with the STROCSS criteria [27]. This study is registered with the ResearchRegistry and the unique identifying number is: researchregistry6461 [28].

2.2. Subject selection

The subjects were patients diagnosed with clinical and radiological evidence of spondylitis tuberculosis who had already undergone surgical intervention by posterior lumbar instrumentation between January 2018 and July 2020. The exclusion criteria were: patients with surgical complications (implant failure, infection); patients with revision surgery of the spine; patients with other diseases that manifest as low back pain (hip joint diseases); incomplete physical examination; loss of follow-up; refuse to participate.

2.3. Clinical outcome measurement

The clinical outcome was measured by health-related quality of life (HRQOL) questionnaire including VAS score and ODI score. The quality of life was measured before and after posterior lumbar instrumentation. All clinical outcomes before the surgery and 6 months after the surgery was extracted from the medical record. The measurement of clinical outcomes 12 months after the surgery was measured directly.

2.4. Radiographic parameter measurement

The measurement of spinopelvic parameters includes PI, PT, SS, and LL. Anteroposterior and lateral spine radiograph before and after posterior lumbar instrumentation were collected digitally from the medical record. The measurement of the spinopelvic parameters was conducted by Surgimap®. All parameters were measured under the supervision of an expert spine surgeon.

2.5. Statistical analysis

Clinical and radiographic measurements were analyzed by IBM Statistical Package for Social Science version 20. A comparison of radiographic parameters was analyzed using dependent T-test or Wilcoxon test. Comparison of clinical outcome between pre-surgical, 6 months, and 12 months measurements was analyzed using the Friedman test followed with the Wilcoxon test as posthoc analysis. Correlation between ODI score and spinopelvic parameters was analyzed using the Spearman test.

3. Results

3.1. Patient characteristics

The median age of the subjects was 31 (9–57) years old. Most of the subjects in this study (60%) were female. The median number of vertebrae segments involved was 2 (1–4 (Table 1. The most common vertebrae segment affected by spondylitis tuberculosis was the lumbar segment (82%) (see Table 1).

3.2. Association between posterior instrumentation and HRQOL

This study showed a significant difference in the ODI and VAS scores before and after posterior instrumentation. In the posthoc analysis, there was a significant difference between VAS before surgery and 6 months postoperatively. VAS scores before surgery and 12 months postoperatively were also significantly different (see Table 2 and Fig. 1) and comparison of ODI score before and after posterior instrumentation (see Table 3).

3.3. Association between posterior instrumentation and spinopelvic parameters

There was no significant difference between radiological spinopelvic parameters before and after posterior instrumentation (see Table 4).

3.4. Correlation between HRQOL and spinopelvic parameters changes

There was no significant correlation between VAS and the change of radiological spinopelvic parameters ($p > 0.05$). However, statistical analysis showed a significant correlation between ODI scores and changes in LL and SS. The correlation between changes in ODI scores and changes in LL and SS showed a negative correlation with moderate strength. The linear correlation formula between change of ODI score and change of LL was $y = 5{,}94–0{,}78x$ with $R2 = 0{,}265$. The linear correlation formula between change of ODI score and change of SS was $y = 61{,}75–1{,}22x$ with $R2 = 0{,}273$. There was no significant correlation between the difference of PT and PI (see Table 5). Association between

Table 1
Subject characteristics.

Characteristics (N = 23)	Category	N	%	Median (Min-Max)
Age				31 (9–57)
Gender	Male	9	39,1	
	Female	14	60,9	
Number of vertebrae involved (n vertebrae)				2,00 (1,00–4,00)
Vertebrae segment involved	Lumbar	19	82,6	
	Lumbosacral	4	17,4	

Table 2
Comparison of VAS score before and after posterior instrumentation.

Variable	N	Median (min-max)	P-value	P-value between two groups
VAS before surgery	23	9 (4–10)	<0,001[F]	Reference
VAS 6 months after surgery		4 (1–7)		<0,001[W]
VAS 12 months after surgery		2 (1–6)		<0,001[W]

[F]Friedman test, [W]Wilcoxon test.

change of ODI and change of lumbar lordosis and sacral slope (see Fig. 2 and Fig. 3)

4. Discussion

4.1. Subject characteristics

In this study, the median age of patients with tuberculous spondylitis was 31 years (9-57). According to Gupta A, the mean age of patients with tuberculous spondylitis was 44.0 ± 12.3 years.[56] Alavi SM reported that the mean age of patients with tuberculous spondylitis was 43.7 ± 18.3 years [9]. The results of this study may be explained by the fact that the BCG vaccine was given to most of the population at an early age, so that complications in the form of tuberculous spondylitis are less common in children and adolescents.

In this study, the proportion of women with tuberculosis spondylitis was higher than men. This is similar to a study by Yu B et al. who reported that the proportion of women with tuberculous spondylitis (57.1%) was higher than men (42.9%) [7]. Mulleman D and Godlwana L also reported that the tuberculosis spondylitis rate was higher in women than in men [10,11]. Longitudinal studies by Holmes CB et al. suggested that women had a higher risk of developing active Mycobacterium tuberculosis infection due to poor nutritional status and delays in seeking help which could be influenced by gender [12,13].

The median number of vertebrae affected by tuberculous spondylitis was two with a range of 1–4 vertebrae. Yu B et al. also reported the involvement of two vertebrae in 67.9% of cases [14]. In tuberculosis of the spine, there was the involvement of more than one vertebra (multivertebra) because the segmental artery in the vertebra bifurcates to supply two adjacent vertebrae. The spread of infection under the anterior or posterior longitudinal ligaments involves several adjacent vertebrae. The absence of proteolytic enzymes in mycobacterial

Table 3
Comparison of ODI score before and after posterior instrumentation.

Variable	N	Median (min-max)	P-value	P-value between two groups
ODI before surgery	23	70 (40–86)	<0,001[F]	Referensi
ODI 6 months after surgery		34 (10–74)		<0,001[W]
ODI 12 months after surgery		12 (2–74)		<0,001[W]

[W]Wilcoxon test.

Table 4
Differences in radiological spinopelvic parameters before and after posterior instrumentation.

Characteristics	Mean ± SD	P-value	*Mean difference* (95% IK)
Lumbar lordotic			
Preop	34,84 ± 17,75		
Postop	30,42 ± 13,85	0,180 [PT]	(-2,20–11,05)
Pelvic incidence			
Preop	51,17 ± 12,67		
Postop	55,45 ± 13,75	0,227 [PT]	(-11,43–2,86)
Pelvic tilt			
Preop	20,08 ± 9,67		
Postop	23,32 ± 12,47	0,359 [PT]	(-10,00–3,77)
Sacral slope			
Preop	32,25 ± 9,61		
Postop	31,08 ± 12,14	0,637[PT]	(-6,24–3,90)

*paired T-Test.

Table 5
Correlation between age, change of radiological outcome, and change of clinical outcome.

		Delta *ODI*	Delta VAS
Spearman Correlation	**Delta PT**	r = -0.324	r = -0.366
		p = 0.131	p = 0.086
	Delta PI	r = -0.019	r = -0.048
		p = 0.932	p = 0.829
	Delta LL	r = -0.604	r = -0.172
		p = 0.002[a]	p = 0.434
	Delta SS	r = -0.555	r = -0.224
		p = 0.006[a]	p = 0.305

[a] Spearman Correlation.

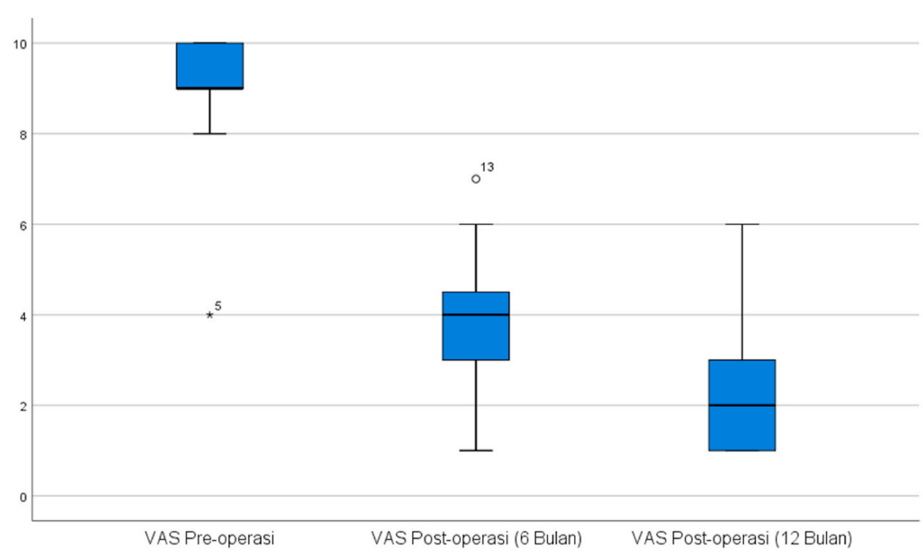

Fig. 1. VAS distribution boxplot.

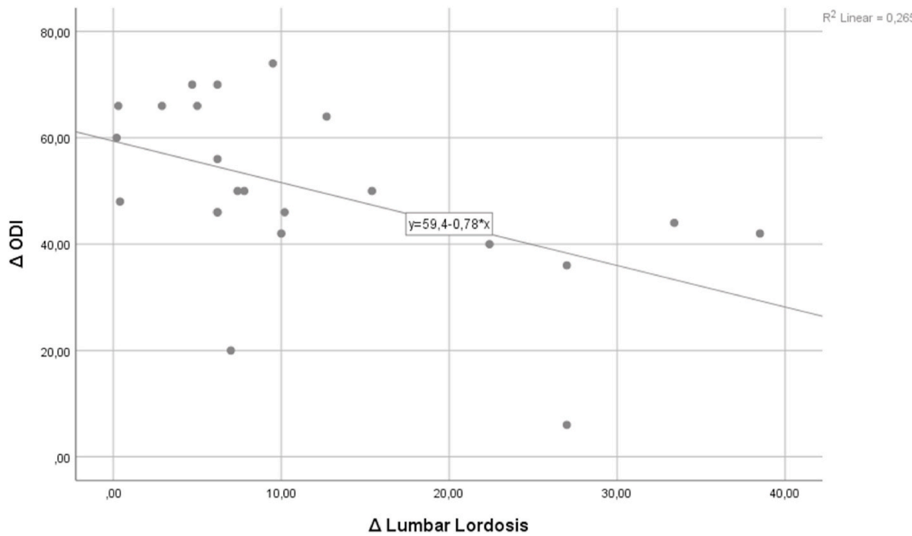

Fig. 2. Association between change of ODI and change of lumbar lordosis.

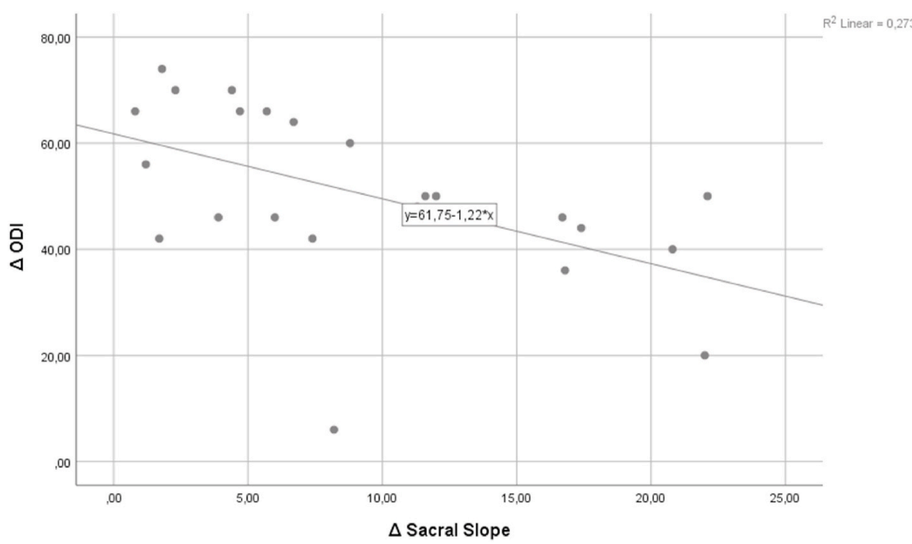

Fig. 3. Association between change of ODI score and change of sacral slope.

infections (as compared to pyogenic infections) has been suggested as the cause of the spread of subligament infection [15].

In this study, the median VAS and ODI before surgery were 9 (4–10) and 70 (40–86) respectively. The results of this study are consistent with previous studies by Kunakornsawat S et al. who reported that the mean VAS before surgery in patients with lumbar tuberculosis spondylitis was 8.1 ± 1,8 [16]. Yu B stated that the mean Oswestry Disability Index (ODI) score in lumbar tuberculous spondylitis patients before the posterior instrumentation surgery was 28.6 ± 4,9 [7]. According to Shetty AP et al., tuberculous spondylitis patients with high ODI scores (severe disability and moderate disability) had lumbar lordosis below 40° while patients with low ODI scores (mild disability) had higher lumbar lordosis above 40° [17]. Therefore, in this study, a high ODI score could be due to lumbar lordosis being below 40°.

4.2. VAS and ODI 6 months after posterior instrumentation

In this study, the VAS score at 6 months post posterior instrumentation was 4 (1–7). The ODI score was reduced to 34 (10–74) at 6 months after posterior instrumentation. These results are consistent with research by Jain et al. According to Jain et al. there was a decrease in VAS score from 8.7 preoperatively to 2.1 at 6 months postoperatively [8]. Improvements in VAS scores at 6 months post posterior instrumentation could occur due to spinal nerve decompression along with improvement in kyphosis deformity.

4.3. VAS and ODI 12 months after posterior instrumentation

In this study, clinical improvement was found after posterior instrumentation as assessed by VAS score and ODI score. The median of VAS score at 12 months after posterior instrumentation that was obtained in this study was 2 (1–6). This was consistent with a study by Kunakornsawat S which stated that the VAS score decreased to 1.7 ± 1.4 at 12 months post posterior instrumentation [16]. The ODI score was reduced to 12 (2–74) at 12 months post posterior instrumentation. The clinical improvement assessed by VAS and ODI at 12 months postoperatively was due to improved function due to the patient's rehabilitation process.

4.4. Radiological outcome characteristics before and after the surgery

In this study, the lumbar lordosis before surgery was 34.84 ± 17.75°.

This was consistent with a study by Shetty et al. who reported the degree of lumbar lordosis before surgery of 32.7 ± 8,2° [17]. Pelvic incidence, pelvic tilt, and sacral slope in this study were 51.17 ± 12.67, 20.08 ± 9.67, and 32.25 ± 9.61 respectively. The value of these parameters was in accordance with a research by Zong J. According to Zong J, the value of pelvic incidence, pelvic tilt, and sacral slope were 47.00 ± 12,193°, 17,69 ± 10,995°, and 29,08 ± 10.436° respectively [18].

In this study, the mean lumbar lordotic before and after surgery was not different significantly. The insignificant relationship in this study could be caused by the comparison of the mean values before and after surgery which was not too far away. Spinopelvic parameters showed a compensation mechanism that required time to improve. One of them was the PT parameter which was a positional parameter that increases with retroversion of the pelvis [19]. A decrease in the postoperative PT parameter had been shown in previous studies with significant changes after 6 months postoperatively which continues to improve within 12 months [20]. This indicates that the change from some spinopelvic parameters does not change immediately after surgery.

4.5. Association between clinical and radiological outcome

The relationship between clinical functional scoring such as VAS and ODI scores with spinopelvic parameters had been described in several previous studies [21–23]. In this study, it was found that there was no significant correlation between PI, PT on VAS scores and ODI scores. However, there was a correlation between SS and LL parameters on VAS and ODI scores in the tuberculous spondylitis population. The correlation strength in SS and LL showed moderate correlation with the correlation coefficient of 0.55 and 0.6. Increasing change of SS and LL values would increase the change of ODI linearly.

In this study, there was no significant difference between changes in PI before and after surgery with ODI and VAS scores. This could be due to the role of PI as an anatomical parameter so that surgery did not significantly change the PI parameters [19]. This study also proved that there were no significant changes in the PI parameters before and after surgery. Previous studies had also shown that posterior instrumentation measures did not show significant changes to the PI parameters [20]. Another study conducted by Tobing et al. showed that an abnormal PI was significantly associated with an ODI score that did not improve after surgery [21]. This result was different in our study because the majority of subjects in this study had PI within normal limits.

In this study, changes in PT parameters were not significantly related to ODI and VAS scores. The insignificant results in this study could be caused by the role of the PT parameter which indicated the presence of pelvic compensation in the form of retroversion due to spinal deformities that were not directly related to ODI scores and pain [24]. Similar results had been described in previous studies which showed no significant difference in ODI scores between normal and abnormal PT parameters [21]. Other studies also showed no significant correlation between PT and ODI scores.76 Oother studies had shown a significant relationship between PT with an angle of 23.4 with VAS with an OR of 0.43 [22]. However, similar results were not obtained in this study which assessed changes in PT before and after surgery. The insignificant association of PT parameters with clinical outcome in this study could be due to insignificant changes in PT before and after surgery and insufficient follow-up time to assess postoperative PT improvement.

There was a strong correlation between SS and LL indicating that the shape of the pelvis determined the type of lumbar lordosis in individuals [25]. SS parameters had normal values between 36 and 42°. In this study, there was a significant correlation between changes in post-operative SS and changes in postoperative ODI scores. The correlation between changes of SS and changes of ODI scores showed moderate strength with a correlation coefficient of 0.55. Similar results were obtained in previous studies which showed a weak correlation between SS and ODI scores [23]. However, SS parameters were not directly related to functional scores and pain because they only represented compensation for existing deformities.

In this study, there was a significant correlation between postoperative changes of LL and changes in ODI scores. However, the analysis showed a moderate correlation with a correlation coefficient of 0.6. In previous studies, the LL parameter did not show any significant difference in the increase in postoperative ODI scores [21]. The moderate strength correlation in this study could be due to the absence of significant differences in LL parameters before and after surgery. Also, the limitation of the sample size may lead to insignificant results for small differences in LL parameters in the groups with mild-moderate disability or mild pain.

This study showed that the difference in preoperative and postoperative ODI had a weak correlation with the difference in preoperative and postoperative lumbar lordosis. Ghandhari H et al. stated that in patients with vertebral sagittal imbalance who underwent corrected osteotomy, the postoperative Oswestry Disability Index (ODI) score correlated significantly with all preoperative radiological parameters ($r = 0.608$, $p = 0.002$ for pelvic incidence and lumbar lordosis; r 0.483, $p = 0.01$ for the pelvic tilt; and $r = 0.464$, $p = 0.02$ for the sagittal vertical axis) [26].

In this study, there was clinical improvement in postoperative patients with improved VAS and ODI scores without significant changes in spinopelvic parameters. The insignificant changes in parameters before and after surgery could be due to variability in the spinopelvic parameters before surgery. The correlation between changes in spinopelvic parameters, especially LL and SS, with ODI scores indicated that postoperative spinopelvic anatomical changes influenced the quality of life of postoperative patients.

The relationship between VAS and spinopelvic parameters in this study showed insignificant results. The insignificant results obtained in this study could be caused by the abnormal distribution of VAS data. This condition can be caused by the fact that the patient had a mild deformity so that there was no large change in the value of the spinopelvic parameters after corrective surgery and posterior instrumentation.

This research could be used as basic data and a reference for similar research in Indonesia in the future. This study was a multicenter study and thus illustrated the heterogeneity of patients with tuberculous spondylitis in Indonesia. The limitation of this study was a recall bias which indirectly affected the results of the study. The COVID-19 pandemic conditions also made it difficult for patients to access hospitals, so that the number of subjects was limited.

5. Conclusion

Posterior instrumentation could improve clinical outcomes in patients with spondylitis tuberculosis of the lumbar. Posterior instrumentation did not significantly associate with correction of the spinopelvic parameter. Change of lumbar lordotic and sacral slope after posterior instrumentation led to an improvement of quality of life marked by the reduction of ODI score.

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Ethical approval

Ethical approval clearance from ethics committee board Faculty of Medicine, Universitas Indonesia with protocol number 19-08-0977.

Consent

Written informed consent was obtained from the patient for publication of this cross-sectional study and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

S Dohar AL Tobing contributes in the study concept or design, data collection, analysis and interpretation, oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team.

Fachrisal contributes in the study concept or design, data collection, analysis and interpretation.

Muhammad Ade Junaidi contributes to the study concept or design, data collection and writing the paper.

Registration of research studies

1. Name of the registry: researchregistry
2. Unique identifying number or registration ID: Reseachregistry6461
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): https://www.researchregistry.com/browse-the-registry#home/registrationdetails/6002ef82a215cd001bc2e931

Guarantor

S Dohar AL Tobing is the sole guarantor of this submitted article.

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Declaration of competing interest

The authors declare that there is no conflict of interest regarding publication of this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2021.01.074.

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