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RESEARCH

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Possible effects of lumbar stabilization surgery on sagittal alignment, disability and quality of life

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Abstract

Background In order to restore the individual's health in lumbar stabilization surgeries, it is aimed to bring the sagittal alignment closer to normal values, to eliminate the findings, and thus to increase the quality of life of the individual by reducing the disability level. The aim of this study is to measure the effects of lumbar region stabilization surgeries performed in our clinic on some angular values in the spine, disability and quality of life. Preoperative (preop) and postoperative (postop) radiographs of 30 individuals over the age of 40 who applied to our clinic with various lumbar region complaints and underwent lumbar stabilization surgery between the years 2020–2022 were taken. Lumbar lordosis, pelvic tilt, sacral slope and pelvic inclination angles were measured from the images obtained. The Visual Analog Scale was used to measure the pain of individuals, the Oswestry Disability Index to measure the disability level, and the Nottingham Health Profile questionnaire to measure the quality of life. Preop and postop data were analyzed with the SPSS 23.0 program and $p<0.05$ was considered significant.

Results The lumbar lordosis angles of individuals who underwent lumbar stabilization surgery approached normal values and the difference between preop–postop lumbar lordosis angle averages was significant ($p<0.05$); It was observed that the harmony between the lumbar lordosis and pelvic inclination angles increased, the pain decreased and the difference between preop–postop pain values was significant ($p<0.05$), disability levels decreased and quality of life increased.

Conclusions The decrease in the level of disability and the increase in the quality of life seen in individuals who underwent lumbar stabilization surgery were associated with the decrease in pain; The changes in angular values are considered to be clinically significant.

Keywords Spondylolisthesis, Oswestry disability ındex, Nottingham health profile, Sagittal angles

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Background

Lumbar stabilization surgeries are frequently used in the treatment of traumas, tumors, spondylolisthesis, lumbar instability, disc degeneration, spinal stenosis and disc herniation causing low back pain [1, 2]. Lumbar region stabilization surgeries are performed with the aim of removing neural compressions, providing spinal stabilization by preventing instability, and thus giving the individual complete independence in daily life by eliminating pain. One of the goals of lumbar stabilization surgeries is to bring the sagittal alignment closer to normal values spine [3]; The spine; ıt has curvatures developed in the sagittal plane in order to ensure its upright posture, to use energy economically and to make its functions sustainable. These are pelvic tilt, sacral slope, pelvic inclination and lumbar lordosis [4]. The pelvic tilt angle is the angle formed by the intersection of the vertical line drawn to the femoral head and the line connecting the midpoint of the promontorium and is an average of 13° [5]. The angle of the sacral slope is the angle between the line drawn parallel to the promontorium and the line drawn parallel to the ground, and its average is 35° [6]. The pelvic inclination angle is the angle between the perpendicular line drawn from the promontorium in the direction of the long axis of the sacrum and the line drawn from the promontorium to the femoral head and is 50° on average [7]. Lumbar lordosis is the inward curvature of the lumbar spine caused by wedging of the lumbar vertebral bodies and intervertebral discs [8]. Although it does not have a reference value, it was stated in a review that the lumbar lordosis angle should be considered individual rather than population-based, but as a general rule, the lumbar lordosis angle is 20°-70° in adulthood [9].

Spinopelvic parameters should be compatible with each other for a balanced and healthy sagittal alignment and spine [10, 11]. Restoration of the normal sagittal spinal alignment after spinal deformity surgery has been found to be an important factor in determining the quality of life after surgery and preventing mechanical complications [12]. Therefore, the aim of this study is to measure the effects of lumbar stabilization surgeries performed in our clinic on sagittal alignment, disability and quality of life.

Working design

This study was planned on a prospective registry basis. The population of the study consisted of 30 individuals (21 women and 9 men) who applied to Kapadokya University Hospital with various lumbar region complaints between September 2020 and January 2022 and were decided to be operated on as a result of the examination performed by the surgeon. For this study, the decision of the Kapadokya University Scientific Research and Publication Ethics dated 09.09.2020 and numbered 29,533,901–204.01.07–14864 and the approval of the chief physician of Kapadokya University Hospital were obtained. The G*Power (Release 3.1.9.7) program was used to determine the number of participants. The power was determined as 80% and the effect size as 0.5. The margin of error was accepted as 0.05. Of the 326 individuals who applied to our clinic and underwent lumbar stabilization surgery, those who were younger than 40 years old, did not have preop radiographic images, had their radiographic images taken in other centers, did not come for routine follow-up after surgery, and did not complete the questionnaire were not included in the study.

Taking radiological ımages

During the routine examination performed both preop and postop 2 months later, the radiological images requested were taken by the same unit and team from the anteroposterior and lateral aspects with the Siemens MULTIX Impact C brand device; while, the operated individual was standing and standing in a neutral position.

Making measurements and angles

Radiological images were transferred to the RadiAnt DICOM Viewer program, and lumbar lordosis, sacral slope, pelvic tilt, and pelvic inclination angles were measured from these images (Fig. 1).

For lumbar lordosis, the angle formed between the line passing over the 1st lumbar vertebra and the line passing under the 5th lumbar vertebra was measured.

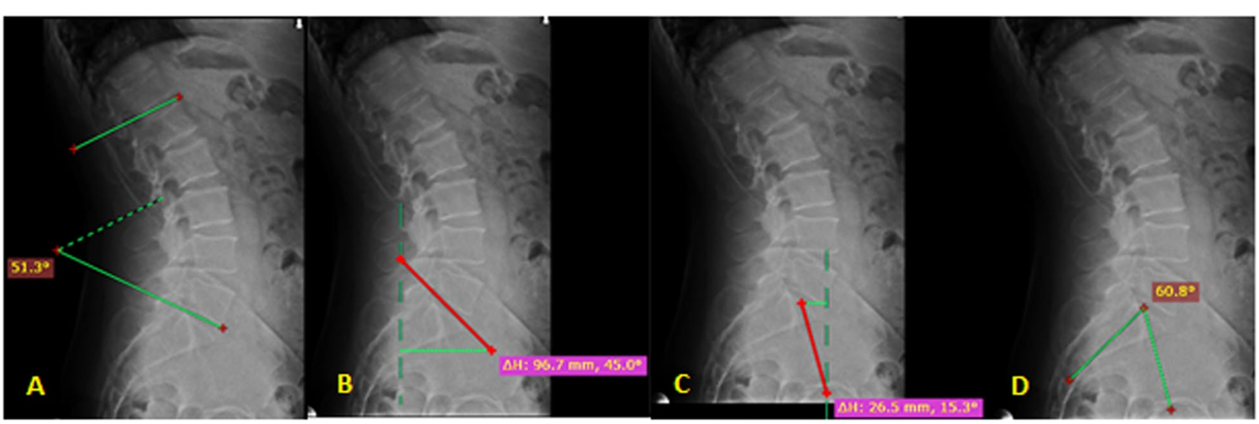

Fig. 1 Measurement of angles. **A**: Lumbar Lordosis, **B**: Sacral Slope, **C**: Pelvic Tilt, **D**: Pelvic Inclination

The angle between the line drawn parallel to the promontorium and the line drawn parallel to the ground was recorded as the sacral slope angle.

While measuring the pelvic tilt angle, a line was drawn from the midpoint of the promontorium to the femoral head and the angle formed between this line and the vertical line was measured.

While measuring the pelvic inclination angle, the angle between the line passing the sacrum vertically through the middle of the promontorium and the line drawn from the promontorium to the femoral head was recorded.

Measurements were made by the same investigator at least 3 times at different times.

Scales used

Visual Analog Scale (VAS) for the assessment of pain; the Oswestry Disability Index (ODI) to determine the disability level of individuals; The Nottingham Health Profile (NHP) scale was used to assess quality of life.

Statistical analysis

IBM SPSS v22 (Statistical package for the sciences) program was used for statistical analysis. Histogram, Q-Q plots and Shapiro–Wilk and Kolmogorov–Smirnov tests were used to determine the normal distribution. Normally distributed data were shown as mean ± standard deviation, and non-normally distributed data as median (minimum–maximum). In the comparison of before and after values, data showing normal distribution were compared with Paired Samples T Test, and data not showing normal distribution were compared with Wilcoxon Test. Correlation of normally distributed data was analyzed by Pearson Correlation Analysis, analysis of non-normally distributed data was analyzed by Spearman Correlation Analysis. A p value of < 0.05 was considered statistically significant.

Results

A total of 30 individuals, 9 (30%) men and 21 (70%) women were included in the study. The mean age of individuals between the ages of 44–84 was 65.40 ± 10.98. The mean age of men was 58.11 ± 12.67, and the mean age of women was 68.52 ± 8.75. Of the patients included in the study, 14 (46%) had spondylolisthesis, 8 (27%) lumbar disc herniation, 3 (10%) sacralization, 2 (7%) lumbarization, 3 (10%) spinal stenosis was diagnosed.

VAS scores preop 7 (4–9); postop 2 (0–4) was found. The difference was considered statistically significant ($p < 0.05$).

The lordosis angles of the individuals participating in the study were 35.38° ± 12.11° preop; postop mean was 39.67° ± 7.01°. The difference was statistically significant ($p < 0.05$) (Fig. 2).

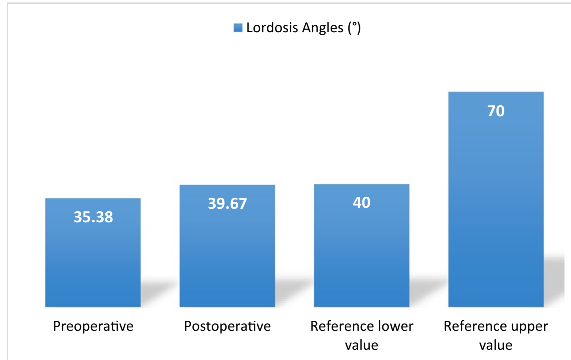

Fig. 2 Lordosis angles

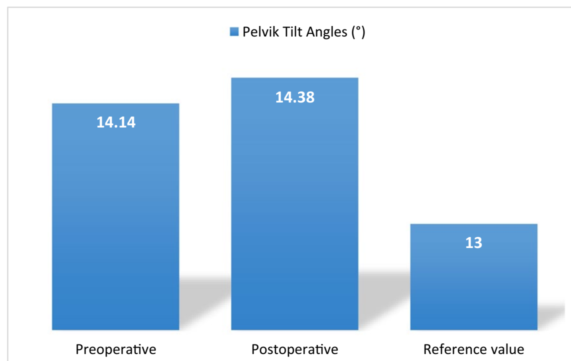

Fig. 3 Pelvic tilt angles

The pelvic tilt angles of the individuals participating in the study were 14.14° ± 4.97° preop; postop mean was 14.38° ± 2.54°. The difference was not statistically significant ($p > 0.05$) (Fig. 3).

The preop mean sacral slope angles of the individuals participating in the study were 34.23° ± 5.87; postop mean was 33.50° ± 3.47°. The difference was not statistically significant ($p > 0.05$) (Fig. 4).

The pelvic inclination angles of the individuals participating in the study were 50.30° (31.20°-57.50°) as the preop median (min–max); postop median (min–max) was measured as 49.30° (39.90°-55.30°). The difference was not statistically significant ($p > 0.05$) (Fig. 5).

The difference between pelvic inclination and lumbar lordosis angles preop 15°; postop was calculated as 10°.

The mean ODI scores of the individuals participating in the study to measure the disability level were calculated as 28.03 ± 6.80 preop and 16.83 ± 6.79 postop. The difference between preop and postop ODI scores was statistically significant ($p < 0.05$). While there was a significant correlation between preop ODI score and age and VAS score, a significant correlation was found between postop ODI score and age (Table 1).

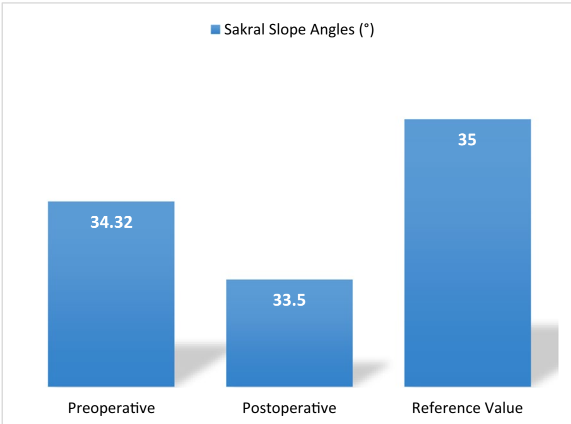

Fig. 4 Sacral slope angles

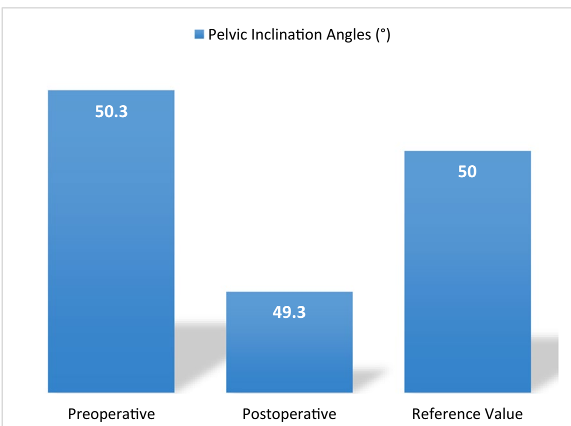

Fig. 5 Pelvic inclination angles

Table 1 Correlation between ODI and other variables

n = 30	Preop ODI		Postop ODI	
	r	*P*	r	*p*
Age[1]	0.869**	0.000	0.937**	0.000
VAS score[2]	0.681**	0.000	0.164	0.387
Lumbar lordosis[1]	-0.032	0.868	-0.096	0.614
Pelvic Tilt[1]	0.035	0.856	0.043	0.823
Sacral Slope[1]	0.103	0.587	-0.098	0.605
Pelvic Inclination[2]	0.131	0.491	-0.197	0.297

**$p < 0.01$ [1]Pearson correlation analysis [2]Spearman correlation analysis

The total score of NHP, which was made to assess the quality of life of individuals, was preop 317.61 (162.34–471.72); postop was calculated as 189.19 (77.79–272.87). The difference was statistically significant ($p < 0.05$) (Table 2).

Table 2 NHP scores

		Preop	Postop	Sig. (*p*)
VAS	Min	46.87	11.22	
	Max	89.51	47.90	
	Med	67.64	25.07	0.00
Emotional Reactions	Min	31.50	0.00	
	Max	53.31	34.89	
	Med	49.38	17.55	0.00
Sleep	Min	16.10	0.00	
	Max	77.63	65.16	
	Med	65.06	27.26	0.00
Social isolation	Min	0.00	0.00	
	Max	22.53	22.53	
	Med	22.53	22.53	0.08
Physical activity	Min	31.07	10.57	
	Max	100.00	66.01	
	Med	60.61	26.53	0.00
Energy	Min	24.00	24.00	
	Max	100.00	100.00	
	Med	60.80	60.80	1.00
Total	Min	162.34	77.79	
	Max	417.72	272.87	
	Med	317.61	189.19	0.00

It was observed that there was a statistically significant correlation between; VAS and ODI with preop pain; age, VAS and ODI with emotional reactions; sleep and age, VAS and ODI; age, VAS and ODI with social isolation; physical activity and age, VAS and ODI; VAS and ODI with energy; NHP total score with age, VAS and ODI scores ($p < 0.05$) (Table 3).

There was a statistically significant correlation between; postop pain with VAS and pelvic tilt; emotional reactions with VAS; sleep with age, VAS and ODI; social isolations with VAS and ODI; physical activity with VAS; energy with VAS and ODI; NHP total score with VAS and ODI ($p < 0.05$) (Table 4).

Discussion

In this study, it was found that lumbar stabilization surgery changed lordosis but did not make statistically significant changes other angles, while reducing pain and disability, it increased quality of life. Relief of pain in lumbar stabilization surgery has been revealed as the most important and expected goal.

Lumbar stabilization surgery is performed to stabilize the spine, correct neurological pathologies, correct spine with misalignment, prevent spine-based deformities and reduce chronic pain [13–15].

There are studies in the literature that emphasize the importance of sagittal alignment and spinopelvic

Table 3 Comparisons with Preop NHP subparameters

n = 30		Age	VAS	LL	PT	SS	PI	ODI
Pain	r	0.279	0.888**	−0.073	0.037	0.247	0.234	0.551**
	p	0.135	0.000	0.700	0.844	0.187	0.213	0.002
Emoti.Reacti	r	0.402*	0.714**	−0.097	0.004	0.159	0.213	0.554**
	p	0.028	0.000	0.608	0.984	0.402	0.257	0.001
Sleep	r	0.376*	0.759**	−0.054	0.313	0.062	0.277	0.714**
	p	0.040	0.000	0.775	0.090	0.744	0.138	0.000
Social isolat	r	0.417*	0.637**	0.106	0.016	0.127	0.245	0.553**
	p	0.022	0.000	0.576	0.932	0.505	0.192	0.002
Physic. activity	r	0.488**	0.842**	0.041	0.010	0.329	0.282	0.809**
	p	0.006	0.000	0.831	0.958	0.076	0.131	0.000
Energy	r	0.316	0.807**	−0.170	−0.057	0.103	0.071	0.477**
	p	0.089	0.000	0.370	0.763	0.589	0.711	0.008
NHP Total	r	0.421*	0.945**	−0.070	0.012	0.268	0.276	0.732**
	p	0.020	0.000	0.714	0.951	0.153	0.139	0.000

* $p < 0.05$ ** $p < 0.01$ Spearman correlation analysis was used

LL: Lumbar lordosis, PT: Pelvic Tilt, SS: Sacral slope, PI: pelvic inclination

Table 4 Comparisons with Postop NHP subparameters

n = 30		Age	VAS	LL	PT	SS	PI	ODI
Pain	r	0.008	0.708**	0.013	0.394*	0.164	0.295	0.189
	p	0.965	0.000	0.947	0.031	0.388	0.114	0.318
Emoti.Reacti	r	−0.012	0.786**	0.062	0.310	0.309	0.306	0.231
	p	0.949	0.000	0.743	0.095	0.096	0.100	0.220
Sleep	r	0.653**	0.416*	−0.090	−0.074	0.209	−0.166	0.740**
	p	0.000	0.022	0.636	0.696	0.267	0.380	0.000
Social isolat	r	0.350	0.496**	−0.012	0.198	0.183	0.136	0.498**
	p	0.058	0.005	0.951	0.293	0.334	0.473	0.005
Physic. activity	r	0.070	0.666**	0.043	0.301	0.336	0.307	0.268
	p	0.714	0.000	0.820	0.107	0.070	0.099	0.153
Energy	r	0.316	0.510**	−0.278	0.087	−0.028	−0.025	0.419*
	p	0.089	0.004	0.137	0.647	0.884	0.897	0.021
NHP Total	r	0.318	0.799**	−0.015	0.244	0.296	0.225	0.544**
	p	0.087	0.000	0.937	0.194	0.112	0.233	0.002

* $p < 0.05$ ** $p < 0.01$ Spearman correlation analysis was used

LL: Lumbar lordosis, PT: Pelvic tilt, SS: Sacral slope, PI: Pelvic inclination

parameters for a balanced and healthy spine. Celestre et al. (2018) emphasized that a spine surgeon should know pelvic tilt, sacral slope, pelvic incidence and lumbar lordosis angles in order to correct lumbar deformities. In the review, the lumbar lordosis angle should be considered individual rather than population-based, but as a general rule, the lumbar lordosis angle is 20°-70° in adulthood; If the difference between pelvic inclination and lumbar lordosis angle is more than 11°, surgical intervention may be required; It has been stated that reducing the lumbar lordosis mismatch with pelvic inclination below 11° is generally the primary goal of adult spinal deformity surgery [9].

Ogura et al. in their study in 2019, they aimed to evaluate the radiographic changes in sagittal spinopelvic alignment after decompression surgery applied to patients with lumbar spinal stenosis and to determine the factors affecting the recovery in sagittal spinopelvic alignment. In their retrospective study, they measured the pelvic tilt, sacral slope, lumbar lordosis and pelvic inclination angles from the lateral radiographs of 89 patients both preop and postop. According to the data they obtained, while the lumbar lordosis angles increased significantly in the postop period; the difference between pelvic inclination and lumbar lordosis has decreased significantly [16]. In our study, preop lumbar lordosis angles were 35.38° ± 12.11°, pelvic inclination angles were 50.30° (min 31.20°, max 57.50°); lumbar lordosis angles were 39.67° ± 7.01° and pelvic inclination angles were 49.30° (min 39.90°, max 55.30°) after surgery. According to the data obtained, both Celestre et al.as well as Ogura et al. like our study, surgical operation increased the compatibility of pelvic inclination and lumbar lordosis angles.

It has been observed that one of the most frequently used scales to measure disability in lumbar region pathologies is ODI. Costa et al. in their study in 2021, in order to determine whether there is a relationship between preop sagittal alignment based on radiographic parameters and clinical outcomes after lumbar decompressive procedures in patients with lumbar spinal stenosis, they applied the ODI scale to individuals in the preop and postop period. In their correlation analysis, they found a negative correlation between lumbar lordosis and ODI score (preop ODI $r = -0.243$, $p = 0.019$; postop ODI $r = -0.235$, $p = 0.033$) and found that ODI score increased as lordosis decreased. As a result of the study, they stated that more than 65% of all patients had "minimally significant difference clinically" in the ODI score [17]. Similarly, in our study, there was a negative correlation between lumbar lordosis and ODI score ($r = -0.032$, $p = 0.868$). While a weak correlation was found between lumbar lordosis and ODI score in both Costa et al. study and our study, the data obtained in Costa et al. study were statistically significant.

It has been proven by studies in the literature that the quality of life of individuals decreases in lumbar region pathologies. In these studies, it was concluded that pain, which is frequently encountered in daily life, reduces the perceived quality of life of individuals. Kilic et al. (2021), the effects of pain beliefs on quality of life and functional status were investigated in elderly people with chronic low back pain. In the study conducted with individuals over 65 years of age, VAS was used to measure pain severity and NHP was used to measure quality of life. At the end of the study, the resting VAS score was 2.27 ± 1.39, the moving VAS score was 7.08 ± 1.19, and the NHP total score was calculated as 281.68 ± 123.55 on average. As a result of the study, the researchers found that as the pain levels increased, the belief scores toward pain increased; pain experienced during activity reduces mobility; physical activity levels, quality of life, social support and quality sleep are closely related to pain beliefs; stated that it is necessary to evaluate pain beliefs in order to improve quality of life, disability and pain in the elderly [18]. In our study, NHP was used to evaluate the quality of life of participants with lumbar region pathologies, and the total NHP score preop was 317.61 (162.34–471.72); postop was calculated as 189.19 (77.79–272.87). According to the analysis of the data obtained in our study, the surgical operation resulted in a statistically significant decrease in pain, emotional reactions, sleep, social isolation, physical activity and NHP total scores.

The lumbar region has sagittal alignment and some sagittal parameters. Knowing these parameters is important and necessary for the success of lumbar stabilization surgeries. One of the goals in lumbar stabilization surgeries is to approximate the sagittal angles to normal values. The results we obtained in our study revealed that lumbar stabilization surgeries brought the sagittal angles closer to normal values.

The most important parameter that increases the disability level of the individual due to lumbar region pathologies is pain. Pain isolates the individual from the social environment, makes him feel bad emotionally and reduces the individual's physical activities. Our study revealed that the relief of pathology-induced pain in lumbar stabilization surgeries with statistical analysis reduces the level of disability.

Limitations

Although the sample size of our study was sufficient according to the power analysis, the inclusion of only 30 (10%) of the data of 326 people in our clinic was not sufficient to find more valuable results. The study could be expanded with more individuals meeting the inclusion criteria.

Abbreviations

NHP	Nottingham health profile
ODI	Oswestry disability ındex
Preop	Preoperative
Postop	Postoperative
SPSS	Statistical package for the sciences
VAS	Visual analog scale

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Not applicable.

Author contributions

KD and EU planned and wrote the study. OA did surgery. KD, OA and HY analyzed and interpreted the data regarding.

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Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

This study was carried out after the decision of the Scientific Research and Publication Ethics of Kapadokya University, dated 09.09.2020 and numbered 29533901–204.01.07–14864 and the approval of the chief physician of Kayseri Private Dünyam hospital.

Consent for publication
The study was explained to each individual and the Kapadokya University Participant Information and Consent form was read and signed.

Competing interests
The authors declare that they have no competing interests.

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