

Correlation between loss of cervical lordosis and the degree of cervical disc herniation



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ABSTRACT

Background: Chronic neck pain is a common health problem and is increasingly relevant in health-related quality of life, not only in industrialized countries. The etiology of neck pain is very complex and may be associated with disc herniation, facet joints, muscles, and ligaments that cervical stability will gradually decrease and can cause damage and lead to loss of cervical lordosis. However, studies rarely report the correlation between cervical lordosis and cervical herniation in patients with neck pain. The purpose of this study was to determine the profile of cervical lordosis curves in patients with chronic neck pain and prove the correlation between the degree of cervical disc herniation with loss of cervical lordosis.

Method: This study was designed as an analytic study with a retrospective cross-sectional approach. Cervical lordosis curves are measured from mid sagittal cervical MRI while the degree of cervical disc herniation is evaluated using a herniation score. The Spearman correlation test and a simple linear regression test were performed to assess the relationship between loss of cervical lordosis and cervical herniation severity. Multivariate analysis was performed to adjust for the effect of confounding variables.

Result: A total of 67 study samples, 64.2% male and 35.8% female, with an average age of 54.7 ± 12.5 . Cervical lordosis angle was found not normal (86.6%), most are in the form of hypolordosis (41.8%) and kyphosis (43.3%). The most herniation was in protrusion stage (47.8%). There was a significant correlation between the loss of the cervical lordosis and the degree of disc herniation ($r = -0.259$, and p -value 0.034), each increase of one cervical disc herniation score affects the angle of the lordosis curve by -1.9 degrees, with a coefficient value of $B = -1,914$ (95% CI, $p = 0.026$).

Conclusion: there is a significant correlation between loss of cervical lordosis and cervical disc herniation ($p < 0.05$).

Keywords: cervical lordosis, disc herniation, chronic neck pain.

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INTRODUCTION

Neck pain is a common health problem and is increasingly relevant in health-related quality of life, not only in industrialized countries. Available figures report that 70% of adults suffer from neck pain at some time in their life while 10% -40% of adults are bothered by neck pain each year. Chronic neck pain that has persisted for more than 6 months in the previous year is reported in 10% -15% of adults. In terms of prevalence, in the population over 40

years of age, 20% have neck pain.¹

The etiology of neck pain is complex and may be associated with herniation of the disc, facet joints, muscles, and ligaments. Excessive movement of the cervical spine, poor posture, lifestyle, and minor neck damage, will cause the cervical stability to gradually decrease and can cause damage and lead to loss of cervical lordosis. Abnormal cervical lordosis, including excessive lordosis, loss of cervical lordosis, kyphosis, and complex cervical lordosis, are the earliest

manifestations of degenerative spine changes. Structural abnormalities of the cervical spine, causing biomechanical dysfunction, bone hyperplasia, cervical muscle injury, and cervical spondylosis which often occur, therefore, it is very important to restore normal cervical lordosis when treating complaints of neck pain.²

Cervical lordosis is the convexity of the cervical vertebrae from the first thoracic vertebra to the level of the foramen magnum. Cervical lordosis curve keeps

the cervical vertebrae in balance, plays an essential role in physiological functions of the body, neck and head posture and helps to maintain the efficiency of various physiological processes such as breathing, vocalization, eye movements and vision. Changes in the cervical spine lordosis curve, including the loss of the cervical vertebral curve which may worsen into a kyphotic curve, have been reported to be closely associated with neck pain, neck stiffness and disability. Various factors are known to trigger the loss of cervical vertebral curve lordosis, including age, gender, congenital abnormalities, trauma, surgery, and degenerative changes in the cervical vertebra, including hernias nucleus pulposus in cervical region.³

Hernia nucleus pulposus (HNP) is a neurological disease of the spine due to degenerative changes or traumatic processes which is the most common cause of neck pain complaints among other causes of neck pain that can occur in the cervical, thoracic and lumbar segments. Cervical herniations are more common than lumbar herniations because the cervical spine is much smaller than the thoracic and lumbar vertebrae and has a broader range of motion and a higher frequency of motion. These conditions result in a higher impact on the cervical spine compared to the thoracic and lumbar spine.⁵

Hernias nucleus pulposus occurs because of the wear and tear mechanism in the aging of each disc between vertebrae, which can cause the disc to collapse and cause herniation of the nucleus pulposus. The most common topical herniation of the cervical nucleus pulposus is at the C5-6, C6-7 and C4-5 levels, respectively. The presence of intervertebral disc collapse in HNP causes a lack of intervertebral height, resulting in the head being more forward and the neck curve to be more straightened, making it more kyphotic. Compression caused by disc herniation can cause cervical space limitation due to pain, and lead to straightening of the cervical curvature due to spasm and contraction of the muscles around the neck. Where decreased flexion and extension ranges and poor head or neck posture occur with cervical HNP therefore measuring this patient's head-neck posture and neck

range of motion is an important part of which should be evaluated.^{1,4}

Abnormal cervical lordosis and cervical herniation are closely associated with neck pain and should be considered before any treatment. However, studies have rarely reported a correlation between cervical lordosis and cervical herniation in patients with neck pain. Some clinicians attribute changes in cervical lordosis to patient neck pain, but different reports can be found in the literature. Changes in lordosis can be seen in individuals without any complaints. Physiological lordosis depends on whether the pain is acute or chronic. In the study of Harrison et al.⁶ the lordotic angle was found to be highest in the normal group and lowest in patients with chronic neck pain; furthermore, the range of normal lordotic angles is reported to be between 31° and 40°. For angles less than 20°, detected a statistically significant association between cervical pain and angle of lordosis. Helliwell et al.⁷ stated that the loss of cervical lordosis could not be associated with acute neck pain and muscle spasms.

This study wanted to determine the profile of cervical lordosis curve in patients with chronic neck pain with cervical disc herniation, and to prove the correlation between the severity of cervical vertebral disc herniation and the loss of cervical lordosis curve evaluated by cervical MRI examination. Although the degeneration process in cervical disc herniation disease is a process that is difficult to avoid, if there is a correlation between the severity of cervical vertebral disc herniation and the loss of cervical lordosis curve, preventive measures can be taken against the worsening of the cervical lordosis curve, thereby reducing the risk to develop disc herniation and severe clinical symptoms. This study aims to determine the relationship between the loss of cervical lordosis curve and the severity of cervical herniation in chronic neck pain patients at Sanglah General Hospital for the period July 2016 - July 2017.

METHOD

This study was designed as an analytical study with a retrospective cross-sectional approach in which the research subjects were selected from the medical records

at Sanglah General Hospital for the period 2016-2017. The angle of cervical lordosis and severity of disc herniation, was measured simultaneously from the results of the patient's cervical MRI. This research was conducted at the Radiology Installation Section of Sanglah Hospital Denpasar-Bali in July 2016 - July 2017. A consecutive sampling method was used for sample recruitment.

The inclusion criteria in this study were male or female adults aged ≥ 21 years with chronic neck/shoulder pain >6 months, having a complete medical record and there is a document on the MRI results, evidence of cervical disc herniation on cervical MRI examination.

This study's exclusion criteria were history of neck trauma or cervical vertebral surgery, radiological images showing congenital vertebral abnormalities, tumors, cervical spondylitis or inflammatory arthritis, not visualizing C2 and or C7, making it difficult to measure the cervical lordosis angle.

Data analysis in this study used SPSS version 25.0 for windows, numerical data were displayed in the form of mean and standard deviation, while categorical data were packaged in the form of frequencies and percentages. Correlation test and linear regression were used to evaluate the relationship between cervical disc herniation scores and the angle of the lordosis curve, then multiple linear regression tests were performed to find the factors that most played a role in the loss of cervical lordosis curve. All values are considered significant if $p < 0.05$.

RESULT

A total of 67 samples from 75 cases of chronic neck pain that were proven to have disc herniation on cervical MRI examination, at Sanglah General Hospital from the period 2016-2017 met the criteria and the data could be analyzed.

Characteristics of study participant

The results of the analysis showed from gender perspective consisted of men (64.2%) and women (35.8%). The mean age in all samples was 54.72 years with a standard deviation of 12.5 years with an age range between 22 years to 81 years (Table 1).

Table 1. Characteristics of study participant

Variable	n=67
Age (Years) (mean±SD)	54.7±12.5
Gender	
Male	43 (64,2%)
Female	24 (35,8%)

Table 2. Characteristics based on disc herniation

Variable	n=67
Cervical angle of lordosis curve (n, %)	9 (13.4%)
Normal	58 (86.6%)
Loss of lordosis curve	
Cervical shape of lordosis curve (n, %)	
Normal	9 (13.4%)
Hypolordosis	28 (41.8%)
Kyphosis	29 (43.3%)
Hyperlordosis	1 (1.5%)
Disc herniation stage (n, %)	
Bulging	31 (46,3%)
Protrusion	32 (47,8%)
Extrusion	4 (6%)
Sequestration	0 (0%)
Spondylolisthesis (n, %)	5 (7.5%)
Cervical spondylosis (n, %)	56 (83.6%)
Compression of cervical vertebral corpus (n, %)	10 (14.9%)
Ossificatio of the posterior longitudinal ligament (OPLL) (n, %)	19 (28.4%)
Facet degeneration (n, %)	10 (14.9%)
Hipertrophy of flavum ligament (n, %)	28 (41.8%)
Disc herniation (n, %)	
1 disc	6 (9%)
2 disc	22 (32.8%)
3 disc	23 (34.3%)
4 disc	11 (16.4%)
5 disc	5 (7.5%)

Table 3. Correlation test between cervical lordosis curve angle and the score of severity of cervical disc herniation

Variable	Median (IQR)	r	P
Cervical lordosis curve	5.2 (27.1)	-0.259	0.034
Cervical disc herniation score	4.0 (3)		

The results of the lordosis curve profile analysis of a sample of chronic neck pain patients with cervical disc herniation showed 13.4% with normal lordosis curve angles and 86.6% abnormal curve angles. Most of the abnormal lordosis curves took the form of hypolordosis (41.8%) and kyphosis (43.3%). Cervical disc herniation stage, found that 46.3% had a bulging disc (stage 1), 47.8% had disc protrusion

(stage 2), and 6% had disc extrusion. There was no disc sequestration of all samples. When viewed from the number of herniated discs, most patients experienced herniation between 2 discs (32.8%) and 3 discs (34.3%) (Table 2).

Bivariable analysis

The correlation variables to be examined were the loss of the lordosis curve which

was assessed based on the angle of the cervical lordosis curve and the variable of the severity of cervical disc herniation which was evaluated using a disc herniation score, where the two variables were not normally distributed, so that Spearman's test correlation analysis was performed. The analysis results showed a negative correlation with the correlation coefficient $r = -0.259$, and p value 0.034. Based on the coefficient of determination $R^2 = 0.067$, indicating that the severity of cervical disc herniation can explain the 6.7% loss of cervical lordosis curve. The scatter graph shows a negative correlation where the greater the herniation's severity, the smaller the angle of the lordosis curve (Table 3 and Figure 1).

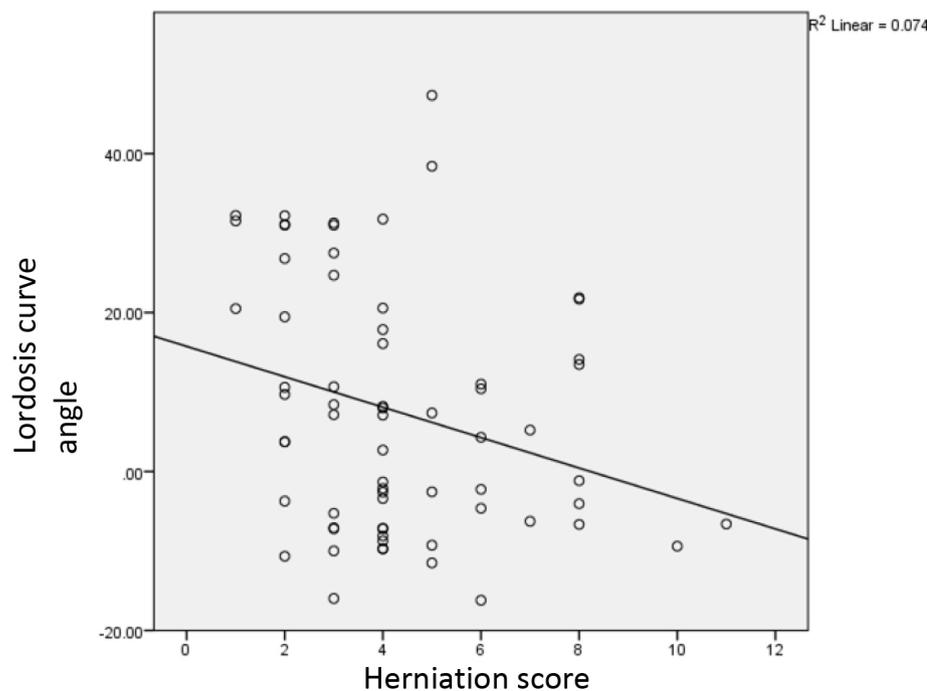
Simple linear regression analysis between the loss of lordosis curve and the severity of cervical disc herniation where both variables are numerical data, the results show that the severity of disc herniation affects the loss of cervical lordosis curve with a coefficient of $B = -1.914$ (95% CI, $p = 0.026$). This shows that each increase of one cervical disc herniation score affects the angle of the lordosis curve by -1.9 degrees. The intercept value was 15.7, which indicates the angle of the lordosis curve if the value of the disc herniation score was 0. Based on the regression equation $Y = A + Bx$, it was obtained that if the herniation score was equal to 1, the lordosis curve angle was predicted to be 13.8 degrees (Table 4).

Multivariable analysis

The loss of cervical lordosis curve can be caused by various underlying pathologies, especially degenerative processes. Multivariate analysis was carried out, where the loss of cervical lordosis curve was assessed based on the angle of the cervical lordosis curve as the dependent variable by controlling for confounding variables namely age, sex, spondylolisthesis, cervical spondylosis, OPLL, facet degeneration, ligamentum flavum hypertrophy. The results of the multiple linear regression give a coefficient of $B = -2.308$ with a value of $p = 0.016$, so that after being controlled with control variables (age, sex, spondylolisthesis, cervical spondylosis, compression of the cervical vertebrae, OPLL, facet degeneration,

Table 4. Linear regression test between the score of severity of cervical disc herniation and the loss of cervical lordosis curve

Variable	B	95% CI		p
		Lower Bound	Upper Bound	
(Constant)	15.749	7.597	23.901	0.000
Disc herniation score	-1.914	-3.595	-0.233	0.026

**Figure 1.** Scatter graph of correlation angle of lordosis curve with score of severity of cervical disc herniation, with correlation coefficient value of $r = -0.259$ ($p = 0.034$), with regression equation: lordosis curve angle = $15.7 - 1.9$ (herniation score) where $p(B) = 0.026$.

ligamentum flavum hypertrophy) there are relationship between herniation score and loss of cervical lordosis curve. Other confounding variables do not show a significant relationship with the loss of cervical lordosis curve (Table 5).

DISCUSSION

The predilection of disc herniation in chronic neck pain patients as evidenced by cervical MRI examination tends to be found in men than in women, especially in the 40-69 age group with a mean age of 54 years. This is in accordance with the literature where men dominate the group of chronic neck pain patients, 30-50% prevalence in middle-aged to elderly people, mostly at the age above 50 years.

The results of the lordosis curve analysis of chronic neck pain patients with cervical disc herniation showed 13.4% with normal lordosis curve angles and 86.6% abnormal curve angles. These abnormal lordosis curves are predominantly hypolordotic and kyphotic. The mean age of patients with both kyphosis and hypolordosis curves was over 50 years. According to the literature, the changes in the curve of lordosis in middle age to old age are caused by a degenerative process, while other causes such as a history of trauma tend to occur at a young age.

The severity of the herniation was assessed based on the score obtained by summing the herniated disc and the grading of the herniated disc. The severity of disc herniation with loss of the lordotic

curve showed a negative correlation, with a coefficient of $B = -1.914$ ($p = 0.026$). Each increase of one cervical disc herniation score affects the angle of the lordosis curve by -1.9 degrees, so that this relationship shows that the more severe the severity of disc herniation the less the lordotic curve is lost, from hypolordosis to kyphosis. In accordance with previous studies with the finding of a negative correlation between disc herniation and the extent of cervical lordosis in neck pain patients, smaller herniations accompanied an increase in lordosis.⁸

A variety of underlying pathologies can cause loss of the lordotic curve. All degenerative processes in the cervical vertebrae can contribute to changes in the lordotic curve. So confounding variables such as spondylolisthesis, cervical spondylosis, OPLL, facet degeneration, ligamentum flavum hypertrophy, age, and sex need to be controlled in the analysis to determine whether the severity of disc herniation is a significant risk factor for loss of cervical lordosis curve. Based on the multivariate analysis, it was found that after controlling for control variables (age, sex, spondylolisthesis, cervical spondylosis, cervical vertebral corpus compression, OPLL, facet degeneration, ligamentum flavum hypertrophy) there was a relationship between the herniation score and the loss of the cervical lordosis curve. Other confounding variables do not show a significant relationship with the loss of cervical lordosis curve.

Another study examining the correlation of degenerative processes in the subaxial cervical vertebral pillar component with the loss of cervical lordotic curve showed no significant correlation between degenerative processes in the subaxial cervical vertebral pillar component and loss of cervical lordotic curve, but a significant correlation was found between posterior listhesis and kyphosis.

A limitation in this study is the retrospective study design in which patient data were obtained from medical records only, where clinical data were incomplete so that it could affect the number of excluded samples.⁹

Table 5. Multiple linear regression tests between cervical disc herniation score and cervical lordosis curve angle after controlling for control variables

Variable	B	SE	95% CI		P
			Lower bound	Upper bound	
Cervical disc herniation score	-2.308	0.926	-4.163	-0.453	0.016
Age	0.136	0.164	-0.193	0.465	0.411
Gender	4.332	4.026	-3.73	12.394	0.286
Spondylolisthesis	-11.548	7.141	-25.847	2.751	0.111
Spondylosis	-5.769	5.466	-16.716	5.177	0.296
Compression of cervical vertebral corpus	3.675	5.610	-7.56	14.909	0.515
OPLL	-3.142	4.577	-12.307	6.023	0.495
Facet degeneration	-3.335	5.649	-14.647	7.977	0.557
Hipertrophy of flavum ligament	-3.307	4.556	-12.431	5.817	0.471

CONCLUSION

This study concludes that the severity of disc herniation correlates with the loss of cervical lordosis curve, where each increase of one cervical disc herniation score affects the angle of the lordosis curve by -1.9 degrees.

CONFLICT OF INTEREST

The author declares there is no conflict of interest regarding publication of this article.

FUNDING

Current study doesn't receive any specific grant from government or any private sector.

ETHICAL CONSIDERATION

Current study has been approved by ethical committee Faculty of Medicine Universitas Udayana/Sanglah General Hospital, Bali-Indonesia with ethical clearance references number: 353/UN14.2.2.VII.14/LP/2020.

AUTHOR CONTRIBUTION

Ni Nyoman Widyasari and Elysanti Dwi Martadiani for data gathering, project administration, writing the original draft and brain storming of main idea. Made Widhi Asih, Firman Parulian Sitanggang, Putu Patriawan, Elysanti Dwi Martadiani for supervision. I Gde Raka Widiara responsible for methodology and guidance in statistical analysis. All author had agree for the final version of the manuscript.

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