



Prevalence of Thoracic Hyperkyphosis in Patients with Adolescent Idiopathic Scoliosis

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Abstract

Background: There are different classifications for adolescent idiopathic scoliosis (AIS), among which Lenke classification is the most recent and comprehensive method. It is 3 dimensional and treatment organized. In most previous studies, thoracic hypokyphosis was more common, but it may be different in many patients.

Objectives: The current study aimed at assessing the prevalence of thoracic hyperkyphosis in AIS for the first time in Iranian population.

Methods: The study was performed retrospectively on 242 patients with AIS treated surgically in the university hospital from 2009 to 2014. Three parameters were evaluated in each patient including the 6 curve types of Lenke classification, thoracic sagittal balance, and lumbar spine modifier.

Results: Adolescent idiopathic scoliosis was more common in female patients (83.5%). Type one curve was the most common type (48%). In lumbar spine modifier, type A was the most common (44%), similar to other studies. Hyperkyphosis was the most common type of thoracic sagittal balance (54%), which was in contrast to the original study by Lenke. The mean thoracic sagittal balance was hyperkyphosis in all Lenke types except type 5, which was normal. No relationship was found between the prevalence of thoracic kyphosis, and lumbar spine modifier, or the 6 types of Lenke classification.

Conclusions: The frequency of different types of curves in Iranian population was the same as that of the original article by Lenke except that in the current study more thoracic hyperkyphosis was observed than hypokyphosis in the population.

Keywords: Adolescent Idiopathic Scoliosis, Thoracic Hyperkyphosis, Lumbar Spine Modifier

1. Background

Old classifications of scoliosis such as the introduced ones by King are based on the coronal plane of thoracic curve (1). Due to more understanding of 3-dimensional character of spinal deformity in adolescent idiopathic scoliosis (AIS), (2-4), and new segmental instrumentation emerged recently (5-8), attention is paid to sagittal balance and rotation of the spine. This led to a new classification system, which incorporated these parameters in itself and was introduced by Lenke et al. (9). The Lenke classification considered 3 parameters:

1. Coronal plane of the curve,
2. Thoracic sagittal balance, and
3. Translation of lumbar curve from central sacral line

(9).

Although there is a hypothetical relationship between

coronal curve and thoracic hypokyphosis in AIS, there are not plenty of studies on the prevalence of different types of thoracic kyphosis (TK) in AIS. In most of the available studies, the frequency of hypokyphosis was more in AIS than hyperkyphosis (10).

2. Objectives

The current study aimed at describing the frequency of different types of TK in AIS, treated in the local center. It was also tried to find a correlation, if any between different types of TK with other parameters of Lenke classification.

3. Methods

For this purpose, the data regarding the patients with AIS treated from 2009 to 2014 were collected from health

database record in Shafa Orthopedic hospital, Tehran, Iran. Inclusion criterion was all patients with AIS treated in Shafa hospital for the first time. Exclusion criterion was all patients with incomplete radiographic studies. Imaging studies were standing posteroanterior, lateral, and right and left supine bending radiographies on a 36-inch cassette. The Cobb method (10) was used for all curve measurements. Lenke classification was used to classify different curves (9). The frequency of each parameter of Lenke classification alone, and their intrarelation was assessed. To measure kyphosis, T5 to T12 curve was measured according to Lenke studies (9). All parameters of the spinal deformities were measured by an orthopedic spine surgeon.

Statistical analysis was conducted with IBM SPSS statistics version 22. Pearson correlation test was used to investigate the correlation between TK, and Lenke type and lumbar spine modifier. The study was approved by the ethical committee of the hospital and written consent was obtained from all patients to publish the results of the study.

4. Results

There were 242 patients with the mean age of 14.3 years, ranged 10 to 23 of which 40 were male, and 202 female. The most common Lenke type was type one (47.9%) and the least common type was type four (4.5%) (Table 1).

The most common lumbar spine modifier was type A (43.8%), and the least common type was type B (19.4%) (Table 2).

The most frequent type of thoracic sagittal balance was hyperkyphosis (positive) (53.7%), and the least common type was hypokyphosis (negative) with the frequency of 7.4% (Table 3).

There was no statistically significant relationship between TK, and the 6 types of Lenke, or lumbar spine modifier. The average TK, in Lenke type 5 was the lowest among other Lenke types. The average TK in all other Lenke types was hyperkyphotic (Table 4). When combining all parameters together, type 1A+ was the most frequent (13.6%) type overall. Some types such as 2C-, 3B-, 3BN, 3C- were not observed at all.

5. Discussion

Three parameters evaluated in Lenke classification were as follows:

1. Type of coronal curve,
2. Thoracic sagittal balance,
3. The position of lumbar spine in relation to the vertical central sacral line.

All these parameters were measured separately, and their relationships were assessed.

The prevalence of curve types in the current study patients was roughly similar to those of Lenke classification in other studies (11, 12).

Lumbar spine is very important to determine the spine balance, and has 3 groups in Lenke classification: A, B, and C (9). Lumbar spine modifier is important to find the required instrumented level. It also predicts spine balance after surgery (11). In this parameter the current study results were similar to those of other studies (11, 12).

Thoracic sagittal balance is important to develop scoliosis (13) and also to decide on surgical or nonsurgical treatment and the type of instrumentation needed during surgical approach (3, 5, 14). The angle between T5 and T12 was measured by the Cobb method and accordingly, thoracic sagittal balance was classified into 3 types: negative, neutral, and positive.

In the current study, hyperkyphosis was the most common type of thoracic sagittal balance with 53.7% prevalence, followed by neutral and negative with 38.8% and 7.4%, respectively. It was different from the patients described by Lenke in which neutral, hypokyphosis, and hyperkyphosis with the prevalence of 75%, 14%, and 11%, respectively, were the most common types in a descending order (11). The highest average TK was observed in Lenke 4 and the lowest in Lenke type 5 of the current study patients. Hu et al., showed that the highest average TK was observed in type 4, and the lowest one in type 1 (12). They also reported that TK in AIS with a thoracic curve was lower than those of the patients with lumbar curve (12). In the current study, hyperkyphosis was even observed in patients thoracic kyphosis with curves. In addition, hypokyphosis was observed in Lenke type 5, which was in contrast to other studies (12, 15-17).

No correlation was observed between Lenke type and lumbar spine modifier. Other studies found that these relationships were very complicated (12).

According to the above three parameters, 42 different curves were introduced. In the current study patients, type 1A was the most common type, similar to Lenke, and Lenke 1A+ was more common than other types. This last one was also in contrast to Lenke original article in which type 1AN was the most common type (11).

The limitation of the current study was the small size of the population assessed, which may lead to the lack of observing all subtypes of Lenke classification.

In conclusion, results of the current study showed that the thoracic hyperkyphosis was the most common type of thoracic sagittal modifier in Iranian patients. It was in contrast to the original article by Lenke and some other studies in which normal kyphosis was the most common type (11, 12).

Table 1. Prevalence of Six Lenke Types of Curves Type

No.	Frequency	Percentage	Valid Percentage	Cumulative Percentage
1	116	47.9	47.9	47.9
2	36	14.9	14.9	62.8
3	34	14.0	14.0	76.9
4	11	4.5	4.5	81.4
5	30	12.4	12.4	93.8
6	15	6.2	6.2	100.0
Total	242	100.0	100.0	

Table 2. Prevalence of Type of Lumbar Spine Modifier

Type	Frequency	Percentage	Valid Percentage	Cumulative Percentage
A	106	43.8	43.8	43.8
B	47	19.4	19.4	63.2
C	89	36.8	36.8	100.0
Total	242	100.0	100.0	

Table 3. Prevalence of Thoracic Kyphosis

Variables	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Thoracic kyphosis < 10	18	7.4	7.4	7.4
Thoracic kyphosis 10 - 40	94	38.8	38.8	46.3
Thoracic kyphosis > 40	130	53.7	53.7	100.0
Total	242	100.0	100.0	

Table 4. Values and Comparison of Thoracic Kyphosis in Different Lenke Types

Lenke Curve Type	Mean	N	Std. Deviation
1	41.35	116	18.23
2	42.11	36	19.15
3	45.64	34	18.62
4	53.81	11	25.34
5	38.50	30	13.11
6	45.73	15	18.47
Total	42.55	242	18.36

Footnote

Authors' Contribution: Study concept and design, Ebrahim Ameri and Farshad Nikouei; acquisition of data, Saeed Sabbaghan and Behrooz Givechian; analysis and interpretation of data, Saeed Sabbaghan, Behrooz Givechian, Abouzar Azizi, and Mehrdad Bahrabadi; draft-

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