Summary of Risks of Progression of Scoliosis

Curve progression according to age at presentation all curve types

Cobb Angle	10-12	13-15	16
<19	25% Brace premenarche, Risser 0/1 Observe & FU 6 month	10% Brace premenarche, Risser 0/1 Observe & FU 6 month	0% R5, Discharge after advice, refer to appropriate clinic for other symptoms
20-29	60% Brace Risser<4, FU 6 monthly	40% Brace Risser<3, FU 9+ monthly	10% <30, R5 Discharge
30-59	90% Surgery 40°+	70% Surgery 50°+	30% R5, 3yr No progression, <50 discharge, Surgery 50°+
>60	100% Surgery	90% Surgery	70% Surgery

Average degree of progression after maturity(degree)

Cobb Angle	Thoracic	Lumbar	Thoracolumbar	Double major	
				Thoracic	**Lumbar**
<30	2.6	None	14	5.6	3
All >30	19				
30-50	10.2	15.4	11	12.7	10.1
50-75	29.4	18.5	19.6	23.1	18.3
75-100	12.6			15.4	11
>100	10.3				

Reference:

1. Nachemson A, Lonstien J, Weinstien S (1982): Report of the SRS Prevalence and Natural History Committee 1982. Presented at SRS meeting, Denver.
2. Weinstein SL, Ponseti IV (1983): Curve progression in idiopathic scoliosis:Long term follow up. J Bone Joint Surg[AM]65:447

Step Down Criteria for Scoliosis Patients to SCM Clinic

- No new patients
- No post operative cases
- Age over 16
- Risser Stage IV+
- Cobb angle > 30° and < 50°
- Follow up appointment at least one year

Criteria for Special Scoliosis Clinic

Please consider referral to Special Scoliosis Clinic (in PM session of every Thursday).
The Criteria for referral are :-

1. They must be patients with idiopathic scoliosis with "cobbs within brace" <=45°

PLUS one of the followings :-

1. cumulative deterioration of cobbs of >= 8° OR
2. cobbs within brace >= 35° OR
3. psychosocial problems such as emotional disturbance with bracing.

Please send the case to Dr. TP Lam for review before referral to Special Scoliosis Clinic.

Scoliosis Patients Discharge Criteria

From SC Clinic :-

- Risser V
- Asymptomatic
- Cobb angle < 30°

From SCM Clinic :-

- Age 22+
- No progression during last 3 follow ups
- Cobb angle < 50°

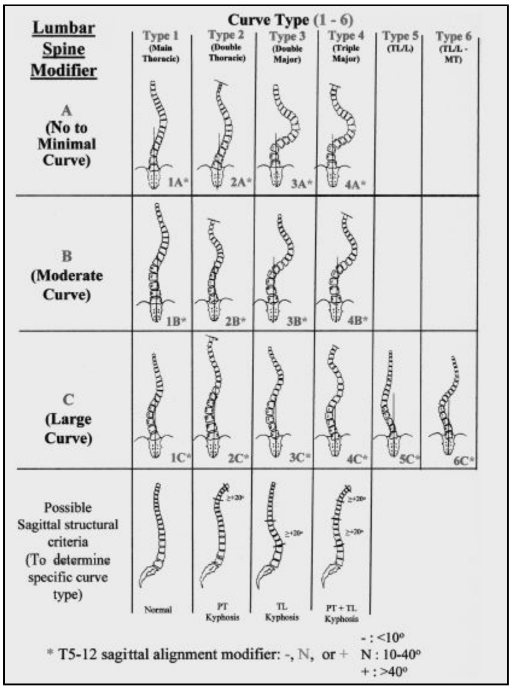
Lenke Classication

Triad: Type, LM, TSM

Important qualifiers:

- Structural Criteria
    1. Coronal plane Side Bending > 25°
    2. Sagittal Plane Kyphosis Upright PT T2-5, T10-L2 > 20°
- Lumbar Modifier(LM)-This is determined by intersection of Mid Sacral Line or Centre Sacral Vertical Line with respects to concave pedicle and lateral vertebral border into:
    1. (medial to pedicle)
    2. (between pedicle & lateral border)
    3. (off lateral border)

    It only totally applies to type 1-4 curves, for type 5&6 only C types
- Thoracic Sagittal Modifier(TSM): T5-12; (-) =< 10°; (N) = 10°-40°; (+) = > 40°

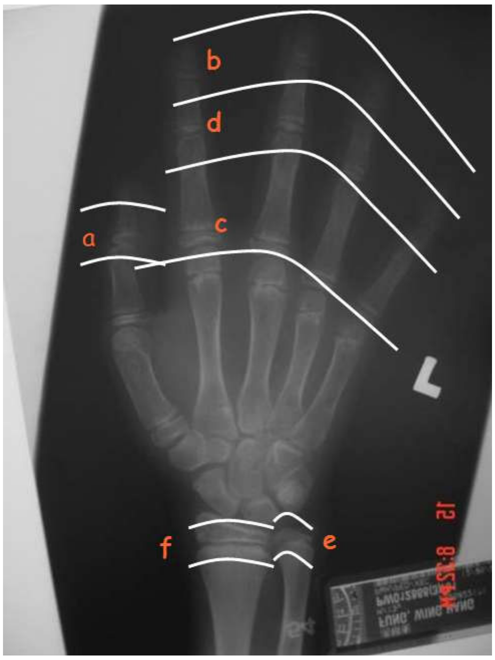


Summary of curve types:

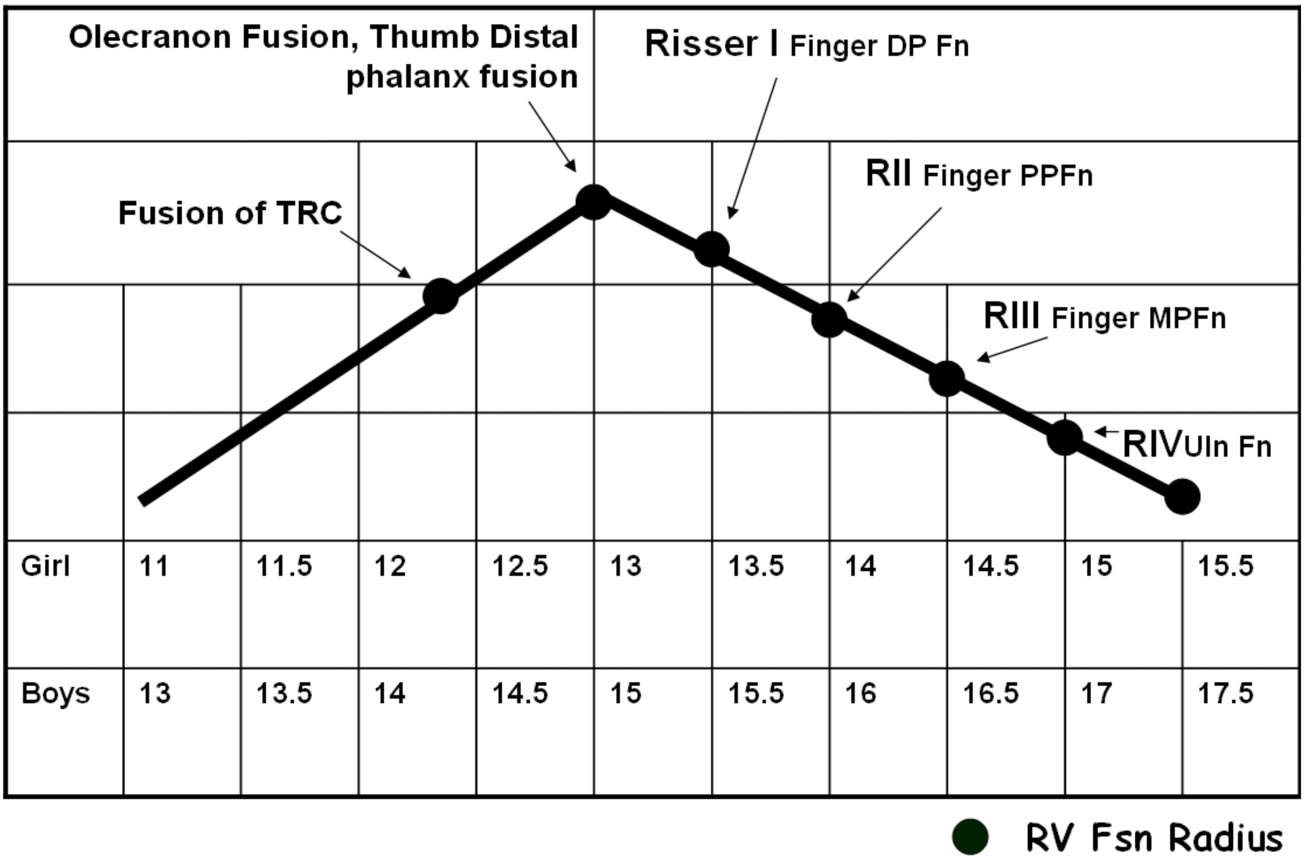
Types	Curve Designation	Lumbar Modifier	Thoracic Sagittal Modifier	Total Combo	Lenke et al %
1	Main Thoracic	A,B,C	-,N,+	9	51
2	Double Thoracic	A,B,C	-,N,+	9	20
3	Double Major	A,B,C	-,N,+	9	11
4	Triple Major	A,B,C	-,N,+	9	3
5	Thoraco-Lumbar	C	-,N,+	3	12
6	Thoraco-Lumber/ Main Thoracic	C	-,N,+	3	3
Total				42	100

Greulich and Pyle Atlas 1959 for Bone Age Epiphyseal Fusion

Ep fusion			girl	boy
a.	TDP		12.5	14.5
b.	DP	R1	13.5	15.5
c.	``	R2	14	16
d.	MP	R3	14.5	16.5
e.	Ulnr	R4	15	17
f.	Rds	R5	15.5	17.5



Growth Rate & Bone Age



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A New Operative Classification of Idiopathic Scoliosis: A Peking Union Medical College Method

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Study Design. A retrospective radiographic study on the type of surgically treated idiopathic scoliosis, with a prospective study on the reliability of the type-related fusion guide.

Objectives. To identify and classify surgically treated idiopathic scoliosis, and define its related fusion levels by a new classification system.

Summary of Background Data. Some classification methods for idiopathic scoliosis have been suggested. However, poor intraobserver reproducibility and interobserver reliability were experienced in these studies, and were not appropriate for guiding surgical planning.

Methods. A total of 427 surgically treated idiopathic scoliosis cases were reviewed. Preoperative and postoperative standing anteroposterior, lateral, and preoperative supine side-bending radiograph were analyzed using the Scoliosis Research Society definition of scoliosis and curve apex. The resulting classification was tested for intraobserver reliability and interobserver reliability, and by 6 surgeons. Apical frequencies were determined for each type, and prospective surgical testing of the new type and its related fusion guide was performed.

Results. Three major types and 13 subtypes were identified, of which the Peking Union Medical College type I accounted for 56.62%, type II 42.16%, and type III 1.22%. The interobserver reliability testing was 85% (kappa coefficient 0.832), while intraobserver reproducibility was 91% (kappa coefficient 0.898). Each type had its corresponding fusion levels. A prospective study of 152 cases was performed according to the classification. All of these cases were followed over 18 months, and no postoperative decompensation was noted.

Conclusion. The Peking Union Medical College classification of idiopathic scoliosis is one system to combine each type with its corresponding fusion level, and it had much higher interobserver reliability and intraobserver reproducibility than the King system. Further prospective studies would help to clarify and expand this system.

Key words: idiopathic scoliosis, classification, Peking Union Medical College. **Spine 2005;30:1419–1426**

Idiopathic scoliosis is a 3-dimensional (3-D) spinal deformity with unknown etiology. Surgical intervention is generally required if spinal deformities are severe or progressive. For the single curve such as thoracic, thoracolumbar, or lumbar curve, there are fewer differences in the selection of fusion level among different spinal surgeons except for the surgical approaches. However, the choice of fusion levels in some type of curves, such as double curves, remains a difficult and controversy issue. Inadequate fusion in these curves may result in postoperative curvature deterioration, trunk decompensation, or even produce new deformity.[1–4] The selection of approach and fusion level should be based on the inherent characteristics of the different curve types. A good classification system should include different types of the curves and should be a guide for surgical planning. Many investigators[1,5–7] have tried to develop an ideal classification system for idiopathic scoliosis. Although it is not an ideal system, the King classification is still the most widely referred system in the literature for surgical planning and comparing the results of different treatment. To establish a comprehensive and reliable system to help surgeons choose an appropriate approach and fusion level, 427 cases of surgically treated idiopathic scoliosis in our department were analyzed, and a new classification system called the Peking Union Medical College (PUMC) system was proposed. This system's reliability and reproducibility were tested.

■ Materials and Methods

Clinical Materials. From February 1983 to January 2001, 1245 patients with scoliosis were admitted and treated in our department. These patients were examined, and a computerized database was created. Of these patients, 427 (34.3%) were idiopathic and had undergone surgical treatment. The sex ratio was 1:2 (male-female), and the average age of the patients was 16.7 years. The higher ratio of male patients in this group may be a result of the distribution of the patients because most in our department were from the underdeveloped countryside, where more care and economic support from the parents came to the boys. Each case was analyzed by a measurement taken from the preoperative supine side-bending radiograph, anteroposterior and lateral standing radiographs taken before and

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after surgery. The second, third, and fourth authors (J.Z., Y.W., and H.X., respectively) of this article retrospectively measured the radiographs of 427 patients.

Methods. In our practice, we believe that the most confused issues are how to define a curvature and to what degree one curve is defined larger than the other. These issues play a key role in the selection of fusion in double and triple curves. To avoid such confusion and improve the reliability and reproducibility of this classification, we used the Scoliosis Research Society (SRS) definition of a curvature (*i.e.,* spine deviates from the midline with a Cobb angle more than 10°, and the furthest horizontal vertebra or disc from the midline on the standing anteroposterior view is defined as the apex).[8] Thus, curves were counted and classified into single, double, and triple curves according to the apex number. The frequency of each curvature type was also calculated.

The general principle of this classification is to preserve more mobile segment as possible, which is reasonable and essential to decrease the degenerative changes of the unfused segments. For this reason, we try to define the criteria for selective thoracic or selective lumbar fusion in double curves. Because a larger curve has poorer compensating ability, it is usually fused to let the smaller curve compensate for the spinal balance. Considering that the interobserver's variability ranges from 4.9° to 11.8°,[9,10] we define a larger curve and a minor curve as a 10° difference, and 2 equivalent curves if the difference is less than 10° to avoid a dispute. Therefore, in this system, selective fusion is fusing a larger curve or fusing the less flexible curve if the 2 curves are equal.

For each case, the following data were measured and recorded:

1. The Cobb angle of each curve.
2. Flexibility of the curvature: flexibility (%) = Cobb angle on standing - Cobb angle on convex bending/Cobb angle on standing × 100%
3. Rotation of the apical vertebra: Rotation of vertebral body was recorded from 1° to 4° using the Nash-Moe method.[11]
4. The stable vertebra: Stable vertebra was defined as the first distal vertebra divided equally by the central sacrum vertical line defined by King et al.[1]
5. Thoracolumbar kyphosis: The Cobb angle between T12 and L1 is more than zero on the sagittal plane.

Based on the radiographic analysis, all the curves were divided into 3 major types according to the total number of the apex, and each major type is then further divided into its respective subtypes according to the location of the apex. Each subtype has its own morphologic pattern and appropriate vertebral fusion levels.

Reliability and Reproducibility. Roentgenographs from 29 cases were selected and numbered randomly by the first author (G.Q.), and classified independently by 6 other senior surgeons from the same department. One case was covered in type Ia, Ib, Ic, IIa, and III, considering the lower frequent of type IIa, III and the simplicity of Ia, Ib, and Ic. At least 3 cases of each subtype II, except for IIa, were covered to test the reliability and reproducibility of the relatively complicated subtypes of type II. All the marks on the films were cleaned before and after each surgeon's review, and the results were collected individually for statistical analysis. The interobserver reliability was analyzed by comparing the results between surgeons. Two weeks later, the same surgeons were asked to repeat the classification using the same films but in a different order, and the results were used to analyze the intraobserver reproducibility. The kappa coefficient, which is between −1 and +1, calculated by coherence tests was used for the assessment. A coefficient more than zero indicates significance, and the higher the kappa coefficient, the better the coherence. A kappa coefficient ≥0.75 indicates an excellent level of coherence.

Clinical Validation. A prospective study was conducted on 152 patients who underwent surgical correction under the guidance of the PUMC classification and who were followed for more than 18 months until June 2002. Curve types and fusion levels were classified by the first 3 senior authors (G.Q., J.Z., and Y.W., respectively).

Results

Characteristics of the PUMC Classification System

In this new PUMC classification system, spinal curvatures were divided into 3 main categories according to the number of apexes to be easily remembered: type I for 1, type II for 2, and type III for 3 apexes. There are a number of subtypes for each curve type, with a total of 13 subtypes (Figure 1). The frequency of each subtype from the 427 cases of idiopathic scoliosis is shown in Table 1.

Surgical Approach and Range of Fusion of Each Type

Indication for surgical treatment includes curvature more than 40° and progression of 5° or more per 6 months except for conservative treatment. The third generation instrumentation is recommended in this system.

PUMC Type I: Single Curve

Subtype Ia. Thoracic curve, apex between T2 and T11–T12 disc. In this group, 175 patients had this type (40.99%, Table 1). Of these patients, 107 had undergone only posterior fusion, 57 anterior release and posterior fusion, and 11 anterior arthrodesis and posterior fusion. When the curve flexibility is less than 50% or the curve is more than 50° on the bending film, anterior release is performed to obtain a better posterior correction. Anterior epiphysiodesis is indicated when the patient is far from skeletal maturity in this group. All the thoracic curves were fused to the stable vertebra (the most proximal vertebra which is bisected by the central sacrum vertical line is defined as the stable vertebra) and had a good coronal balance. Therefore, thoracic fusion to the stable vertebra is suggested for type Ia.

Subtype Ib. Thoracolumbar curve, apex at T12, T12L1 disc, and L1. This type accounts for 7.73% (Table 1). Of the 33 patients, 22 had undergone only anterior fusion with instrumentation, 7 anterior release and posterior fusion with instrumentation, and only 4 underwent posterior fusion. Of the 22 patients with anterior fusion, a mean of 2.1 segments were saved compared with a standard posterior procedure. Seven of these 22 patients had fusion from end-to-end, and 15 had short segmental fu-

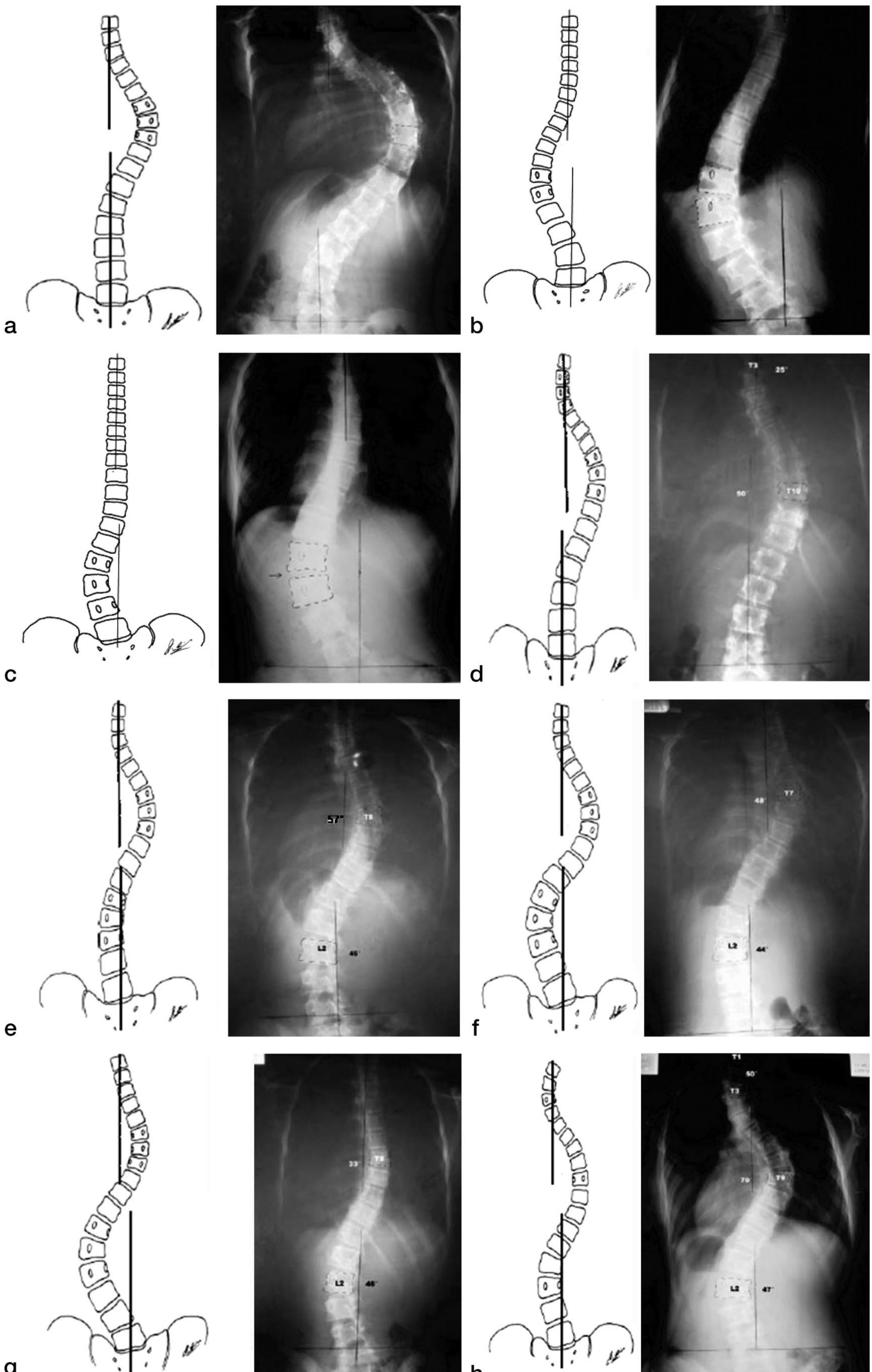

Figure 1. **a**–**h**, Schematic drawing and related radiograph films of PUMC classification. **a**, PUMC Ia. **b**, PUMC Ib. **c**, PUMC Ic. **d**, PUMC IIa. **e**, PUMC IIb. **f**, PUMC IIc. **g**, PUMC IId. **h**, PUMC III. The dotted line is the plumb line passing the spinous process of C7, and the black line is the center sacrum vertical line.

Table 1. The Percentage of Each Type of PUMC Classification

PUMC Type	Case No.	Percentage
I		
Subtype Ia	175	40.99
Subtype Ib	33	7.73
Subtype Ic	33	7.73
II		
Subtype IIa	13	3.05
Subtype IIb1	57	13.35
Subtype IIb2	51	11.94
Subtype IIc1	3	0.70
Subtype IIc2	3	0.70
Subtype IIc3	15	3.51
Subtype IId1	28	6.56
Subtype IId2	10	2.34
III		
Subtype IIIa	3	0.70
Subtype IIIb	3	0.70

sion according to the Hall principle,[12] and both coronal and sagittal balance were maintained, except that 2 patients with short segmental fusion had increased disc angle distal to the inferior fusion vertebra. A mean 13° of thoracolumbar kyphosis in 5 patients was corrected to 3.5°. For type Ib, we recommend anterior fusion with instrumentation except for cases with a curve more than 60° and flexibility less than 50%, or a curve more than 50° on the bending film. According to Hall *et al*,[12] the principle of selection of short segmental fusion levels is: (1) If the apex is a vertebra on standing anteroposterior (AP) film, instrument one vertebral body above and below; if a disc, instrument 2 vertebral bodies above and below. (2) On convex bending film, the first disc space above and below the apex that opens up can be left unfused; on concave bending film, vertebral bodies below the apex should be parallel to the sacrum. If there is a discrepancy among the levels indicated in the aforementioned 2 methods, the longest segment of instrumentation always should be selected.

Subtype Ic. Lumbar curve, apex between L1–L2 and L4–L5 intervertebral disc. A total of 33 patients were classified as having this type (7.73%, Table 1). Of these patients, 21 had undergone anterior fusion to L3, 9 had fusion to L4, and 3 had undergone anterior release and posterior fusion to L5 because of a rigid tilt of L4. For type Ic, anterior correction and fusion will achieve better results compared with long segmental posterior fixation to preserve more mobile segments. Usually an end-to-end fusion, from the upper end vertebra to the lower end vertebra, is needed for type Ic (Figure 2, available for viewing online through ArticlePlus only).

PUMC Type II: Double Curves

Subtype IIa. Double thoracic curves (13 patients, 3.05%) (Table 1). Both curves were fused superiorly at or below T2 and inferiorly to the stable vertebra of the lower thoracic curve.

Subtype IIb. Thoracic curve plus thoracolumbar/lumbar curve, the former is at least 10° higher than the latter. It is further divided into 2 subtypes: IIb1 and IIb2. Subtype IIb1 should meet all the following 4 criteria: (1) without thoracolumbar/lumbar kyphosis; (2) a Cobb angle of thoracolumbar/lumbar curve ≤45°; (3) rotation of thoracolumbar/lumbar curve less than 2°; and (4) flexibility of thoracolumbar/lumbar curve ≥70%. Subtype IIb2 does not meet any of the aforementioned 4 criteria. In this group, there were 57 IIb1 and 51 IIb2 cases (Table 1). Of the 57 patients with subtype IIb1, 21 underwent posterior selective thoracic fusion using 3-D instrumentations, with a minimum one-year follow-up. Both curves of the other 36 patients were fused distally to L3 or L4, and an extra 2.9 segments were fused compared with posterior selective thoracic fusion. The mean coronal Cobb angle of lumbar curve before surgery was 34.6° (25°–45°), mean flexibility was 84.7% (range 62.5% to 100%), apical rotation was within grade I (Nash-Moe method), and apical translation was 10.0 mm (range 4.5–15.4). Derotation and distraction maneuver was applied in all these cases. At the final follow-up, trunk shift was 3.6 mm (range 0–12), the mean Cobb angle of the thoracic and lumbar was 18.8° and 15.9°, respectively, and no thoracolumbar kyphosis was noted (Figure 3). Thus, for type IIb1, selective thoracic fusion to the stable vertebra of the thoracic curve is recommended, while type IIb2 needs fusion of both curves.

Subtype IIc. Thoracic curve plus thoracolumbar/lumbar curve, the curve magnitude difference is less than 10°. By comparing the curve flexibility, it is further divided into 3 subtypes.

- IIc1: Flexibility: Thoracic curve is more than the thoracolumbar/lumbar curve; the Cobb angle of the thoracic curve on convex bending radiograph is ≤25°.
- IIc2: Flexibility: Thoracic curve is more than thoracolumbar/lumbar curve; Cobb angle of the thoracic curve on convex bending radiograph is more than 25°.
- IIc3: Flexibility: Thoracic curve is less than the thoracolumbar/lumbar curve.

For type IIc1, selective anterior fusion of the lower curve is sufficient because the upper thoracic curve is milder and more flexible, and, thus, would compensate automatically. Selection of fusion levels is similar to Ib and Ic. For type IIc2, posterior fusion of the 2 curves is recommended, but if the rotation of the lower curve is larger than grade II or the Cobb angle is more than 65°, then an anterior correction and fusion of the lower curve combined with a posterior fusion of the 2 curves are necessary. For type IIc3, selective thoracic fusion or double curve fusion should be performed based on the fusion criteria of type IIb.

Subtype IId. Thoracic curve plus thoracolumbar/lumbar curve, the former is 10° smaller than the latter.

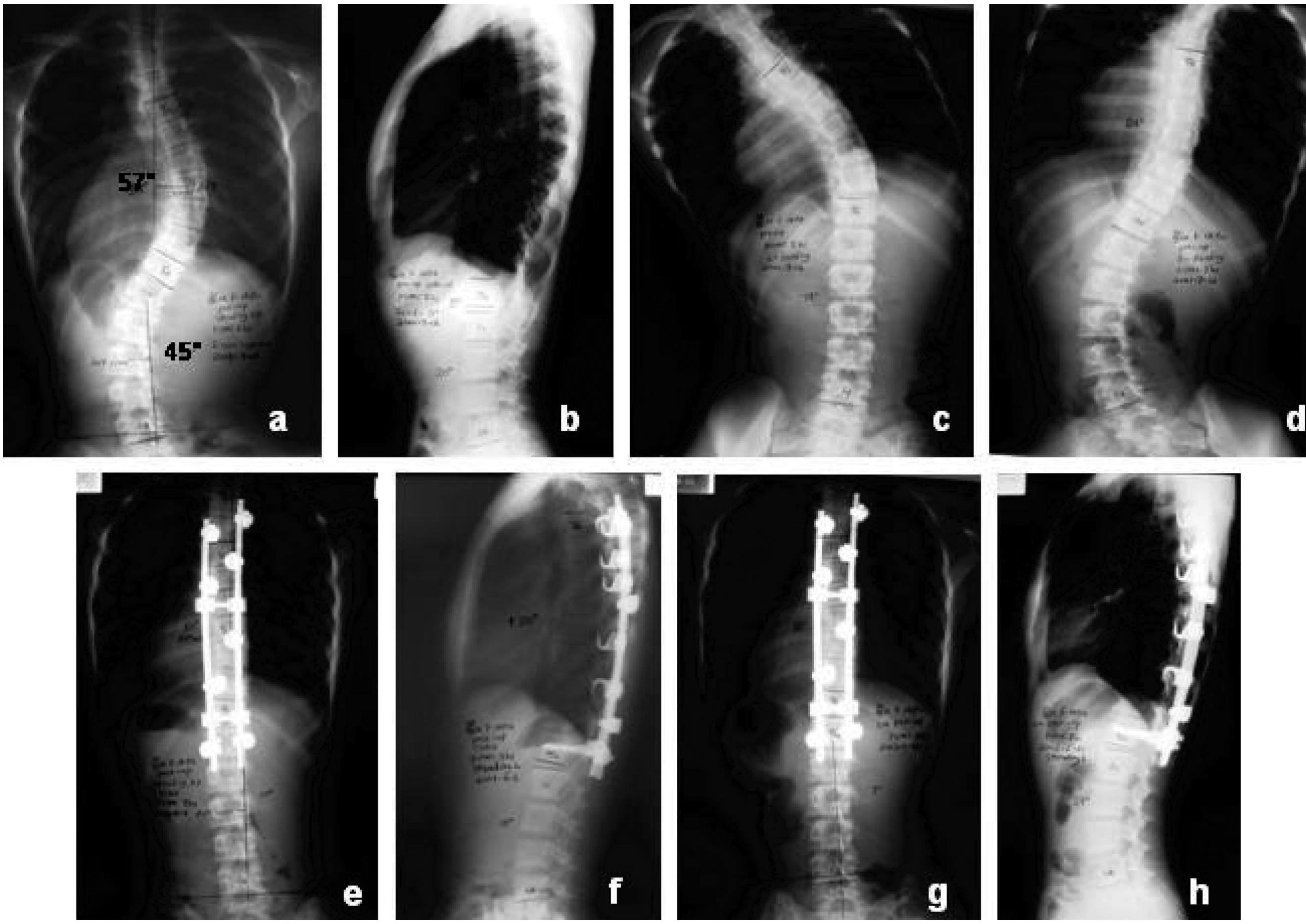

Figure 3. A 14-year-old-female with PUMC type IIb1. **a**, The thoracic curve was 57° and the lumbar curve 45°, lumbar apical vertical translation was 19 mm, while apical vertebral rotation (AVR) was grade I. **b**, No thoracolumbar kyphosis was found. **c**, **d**, The supine bending films showed the lumbar flexibility was more than 70%. **e**, **f**, After selective posterior thoracic fusion with Texas Scottish Rite Hospital (instrumentation), both coronal and sagittal balance were well maintained. **g**, **h**, The radiograph at 6-month follow-up shows that the corrected thoracic curve and kyphosis are still well maintained.

This type is divided into 2 subtypes according to the flexibility of the thoracic curve:

- IId1: Cobb angle of the thoracic curve on convex bending radiograph is ≤25°
- IId2: Cobb angle of the thoracic curve on convex bending radiograph is more than 25°

For type IId1, selective anterior fusion of the lower curve is recommended, and for IId2, double curve fusion is necessary to avoid postoperative decompensation of the thoracic curve.

In this group, all 3 patients with type IIc1 and 13 of 28 patients with IId1 (Table 1) underwent selective fusion of the lumbar or thoracolumbar using the 3-D instrumentations. There was transient deterioration of trunk shift after surgery from 19.5–23.4 mm. However, all trunk shifts recovered within 20 mm at the 6-month follow-up (Figure 4, available for viewing online through ArticlePlus only). Only one patient had 20° of disc angle distal to the lower end fusion vertebra as a result of over derotation and compression of the lumbar (Figure 5).

PUMC Type III: Triple Curves

Subtype IIIa. The distal curve meets the criteria of the lumbar curve of IIb1, therefore, selective fusion of the 2 proximal curves is suggested without needing to fuse the distal lumbar curve because it is milder and more flexible.

Subtype IIIb. All 3 curves should be fused because the distal lumbar curve is larger and more rigid. If not fusing all the curve, decompensation will definitely occur in future (Figure 6, available for viewing online through ArticlePlus only).

Interobserver Reliability and Intraobserver Reproducibility of the PUMC Classification System

The results obtained by the 6 surgeons after studying the radiographic films of 29 cases are listed in Table 2. By measuring the curve magnitudes and apical translation, determining curve apexes, recording apical rotation, and calculating the curve flexibility, the 6 reviewing physicians define the curve type. Based on their agreement on each subtype, the interobserver reliability and intraob-

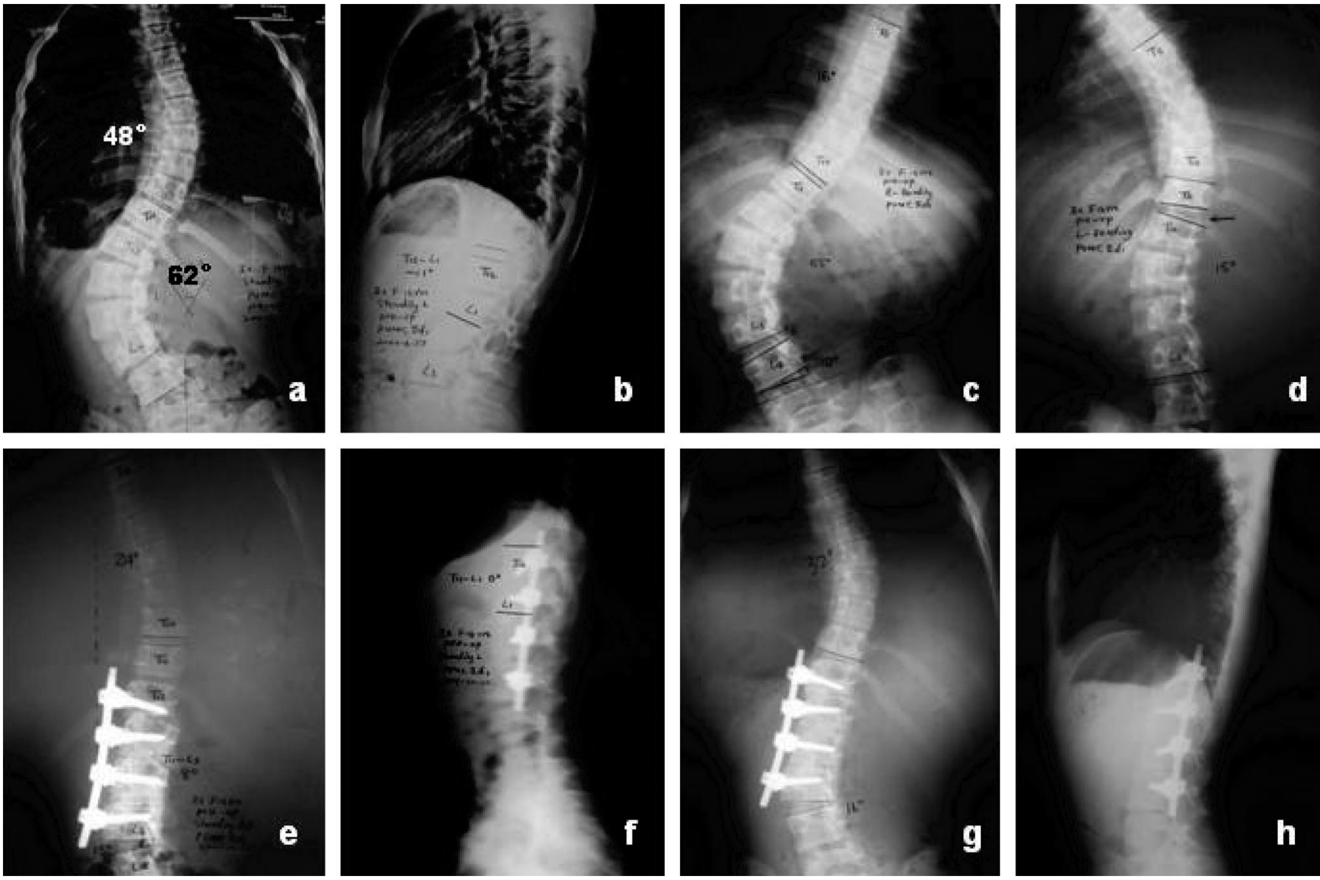

Figure 5. **a–d**, A 16-year-old female with a thoracic (48°) and lumbar curve (62°). The thoracic curve was corrected to 16° on convex bending film and was classified as type IId1. **e**, **f**, A selective short lumbar fusion was performed and trunk shift increased, and the disc angle at L3,4 opened because of over derotation and compression. **g**, **h**, At 1 ½-year follow-up, trunk shift recovered, and disc angle was maintained at 20°.

server reproducibility were analyzed. The 6 reviewers agreed on the 13 subtypes. The more frequently, differently classified subtypes were Ia and Ib, which were regularly classified as IIb1 and Ic, respectively, because the junctional lumbar tilting is easily classified as a minor lumbar curve. The average reliability of this system was 85%, with a kappa coefficient of 0.832 (>0.75), and mean reproducibility was 91%, with a kappa coefficient of 0.898 (Table 3).

Table 2. The Analysis of the Interobserver Reliability of PUMC Classification

Observer	No. of Same Classification	Percentage of Same Classification (N = 29)	Kappa Coefficient
1–2	25	86	0.847
1–3	26	90	0.886
1–4	24	83	0.809
1–5	24	83	0.809
1–6	25	86	0.847
2–3	24	83	0.809
2–4	23	79	0.771
2–5	24	83	0.809
2–6	23	79	0.771
3–4	25	86	0.847
3–5	25	86	0.847
3–6	26	90	0.886
4–5	26	90	0.886
4–6	25	86	0.847
5–6	24	83	0.809
Mean		85	0.832

Clinical Validation

We have performed a prospective study of 152 cases according to this new classification system. There are 96 females and 56 males, which includes 40 cases of type Ia, 19 of Ib, 17 of Ic, 14 of IIb1, 21 of IIb2, 14 of IIc3, 16 of IId1, 7 of IId2, 2 of IIIa, and 2 of IIIb. Average age was 14.5 years (range of 10–19). Fusion was performed strictly by the prescriptive approach and fusion level. The preliminary results showed no trunk decompensation or other complications related to the selection of

Table 3. The Analysis of Intraobserver Reproducibility

Observer	Percentage of the Same Repeated Classification (N = 29)	Kappa Coefficient
1	93	0.924
2	86	0.847
3	86	0.847
4	93	0.924
5	93	0.924
6	93	0.924
Mean	91	0.898

fusion level. The case in Figure 6 was reviewed in the retrospective study, and it is not the case included in the prospective study.

Discussion

Classification of idiopathic scoliosis has always been an area of contention in spinal surgery because it has a direct relationship with the surgical outcomes. The aim of classification is to assist the selection of an appropriate approach and range of vertebral fusion levels. An ideal classification system should have the following characteristics:

1. Comprehensiveness: All types of common idiopathic scoliosis should be considered easily, not only the coronary and sagittal deformities but also the axial deformities.
2. It should be easily understood and remembered, and possess a level of reliability and reproducibility.
3. Each type of curve should correspond to an appropriate surgical procedure and fusion level to guide the treatment selection process.

Schulthess[3a] was the first to classify idiopathic scoliosis using the categories cervicothoracic, thoracic, thoracolumbar, lumbar, and double curves. Thereafter, other investigators found that cervicothoracic curve was nonexistent and classified idiopathic scoliosis into between 5 and 9 types.[5] Winter and Lonstein[6] divided it into 7 types according to the morphologic pattern of the curvature. Coonrad *et al*[7] classified it into 9 types, and 11 subtypes in terms of the location of the apex and direction of the curve after analysis of 2000 cases of idiopathic scoliosis. They provided a morphologic database of idiopathic scoliosis, which can help analyze the distribution of different kinds of scoliosis.

King *et al*[1] first described 5 type thoracic curves and their related fusion levels. It is the first operative classification system in history, and many surgeons used it as a guideline in their practice. However, this system only included the thoracic curves and classified them only in the coronal plane, so many problems occurred when it was applied for the treatment of idiopathic scoliosis using 3-D instrumentation. The most common problem is postoperative decompensation after selective thoracic fusion in King type II curves,[13–16] and comparative studies among different institutes and procedures are limited because of its lower reliability (64%) and reproducibility (69%).[17,18]

Lenke *et al*[19] developed a new system that included an analysis of coronal and sagittal deformities. It contains 6 types with 1−9 subtypes in each. It is a relatively comprehensive classification system, with a high reliability rate of 92% and reproducibility rate of 83%, which are much higher than the King-Moe system. However, the description of curvatures in the Lenke system can be misunderstood because it involves a more complex concept of structural curves, which is still controversial. Ogon *et al*[20] reported that the reliability of the Lenke system was only 41%, which was much lower than that reported in the original study by Lenke *et al*[19]. In addition, it does not give a guide to appropriate fusion levels and surgical approach for each type of curve.

With the financial support of the Ministry of Health of the People's Republic of China, the PUMC Classification System was established based on 20 years of patient follow-up, data collection, and analysis of the large number of scoliosis cases in our hospital. It classifies idiopathic scoliosis into 3 types according to the number of curves, the SRS definition of curvature, and apex. Each type is divided into several subtypes depending on the characteristics of 3-D deformities and the flexibility of the curvature. The PUMC classification system recognizes all coronal, sagittal, and also axial spinal deformities. Therefore, it considers a wider range of patients with scoliosis, including those with delayed diagnosis or very severe and rigid deformities.

The most outstanding characteristic of this system is that with each classification type, the appropriate surgical approach and fusion level are provided, maintaining as many mobile segments as possible. The most challenging part of this system seems to be type II, which looks much too complicated. However, it is easier to be understood and remembered if the general principle of fusing as few segments as possible is realized, and that is why it has relatively higher reliability and reproducibility, 85% and 91%, respectively. Every classification system seemed to have much lower reliability and reproducibility at other centers[17,19,20] than the original study. Therefore, further study of the reliability and reproducibility of this system at other spinal centers is needed. Also, a long-term prospective study is mandatory to modify and improve this system.

Key Points

- The PUMC classification system categorizes idiopathic scoliosis into 3 types according to the number of curves, the SRS definition of curvature, and apex.
- Each type is divided into several subtypes depending on the characteristics of 3-D deformities and the flexibility of the curvature.
- The classification system recognizes all coronal, sagittal, and also axial spinal deformities, and is useful for selecting a surgical approach and fusion level.
- It is also easily understood and remembered, and has better interobserver reliability and intraobserver reproducibility than the King system.

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