

# A new severity scoring system designed for the management of adult spinal tuberculosis—a retrospective case series study

**Qi Wang**

Chinese PLA General Hospital

**Xiaobo Luo**

8th Medical Center of Chinese PLA General Hospital

**Chi Wang**

Chinese PLA General Hospital

**Wenhao Hu**

Chinese PLA General Hospital

**Litao Li**

8th Medical Center of Chinese PLA General Hospital

**Fanqi Hu**

Chinese PLA General Hospital

**Yan Wang**

Chinese PLA General Hospital

**Yuanzheng Ma**

8th Medical Center of Chinese PLA General Hospital

**Xuesong Zhang** (✉ [zhangxuesong301pla@163.com](mailto:zhangxuesong301pla@163.com))

Chinese PLA General Hospital

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## Research article

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# Abstract

**Background:** Surgeons have been successfully handle with spinal tuberculosis via conservative or surgical treatment. However, There are quite few classifications or scoring systems concerning spinal tuberculosis to guide the surgeons to manage the complicated pattern of spinal tuberculosis. The purpose of this study is to design a practical, yet comprehensive, severity scoring system for spinal tuberculosis that helps in clinical decision-making in terms of the need for operative versus non-operative management.

**Methods:** A group of 129 spinal tuberculosis cases (70 male and 59 female patients) successfully treated and followed up for at least 2 years were retrospectively reviewed. Clinical spine experts from our institutions were gathered to confirm the information they considered pivotal in the communication of spinal tuberculosis and the clinical decision-making process. Typical spinal tuberculosis patterns were reviewed and reconsidered in view of these essential characteristics. An initial validation process to determine the reliability and validity of this system was also undertaken.

**Results:** A new severity scoring system was designed based on three essential characteristics: 1) the stability of spinal infectious segments determined by imaging appearance, 2) the cause of spinal cord compression and the severity of neurologic deficit, and 3) the efficacy of the anti-tuberculosis drug therapy. A severity score was calculated from these characteristics, which divided patients into surgical and nonsurgical treatment groups.

**Conclusions:** The severity scoring system comprehensively considers features cited in the literature including prediction of spinal stability and kyphosis deformity progression, identification of neurologic compromise and characteristics of mechanical compression of spinal cord. This classification system is intended to facilitate clinical decision-making in the management of adult spinal tuberculosis (from C3 to L5 segments) . The severity scoring system may help to improve the communication among spine surgeons. Further studies are needed to determine the reliability and validity of this system.

## Background

Spinal tuberculosis is the most common type of bone and joint tuberculosis. With the deep understanding of treatment for spinal tuberculosis and the application of anti-tuberculosis drugs since 1940s, the cure rate of spinal tuberculosis has significantly improved <sup>1</sup>. Surgery is mainly applied to handle the complications caused by tuberculosis. However, due to the diversity and complexity of spinal vertebral destruction shown via imaging, divergence occurs among spine surgeons concerning the choice of treatment options. In addition, consensus concerning the indications for both conservative treatment and combination of drugs and surgery cannot be reached.

Although several classification systems for spinal tuberculosis have been described and promoted <sup>2-7</sup>, they remain controversial and have not gain universal acceptance. There is no widely accepted classification system partly due to the following factors. Firstly, application, validity and reproducibility of

certain systems are difficult in clinical practice. Secondly, these classification systems fail to comprehensively take into account characteristics including element compressing the spinal cord, stability of spine, predictors of spinal deformity, severity of neurological deficit and efficacy of anti-tuberculosis (TB) drugs. Thirdly, these types of classifications do not cover all the complexity, variability and different anatomical features of spinal tuberculosis. Meanwhile, with the arise of techniques including percutaneous puncture drainage via the ultrasound or CT guiding in the treatment of paraspinal or psoas tuberculosis abscess<sup>8</sup>, and the effective use of negative pressure wound therapy in treating tuberculosis sinus<sup>9</sup>, abscess and sinus are not the main factors that determine the surgical approach.

Thus, this retrospective study aims to present a novel and clinically useful severity scoring system to assist spinal tuberculosis management. We evaluate patients with spinal tuberculosis treated with different methods. Experts of spinal tuberculosis surgeon from our institutes were gathered to discuss the pivotal characteristics for clinical judgment and decision-making in treatment of spinal tuberculosis ( from lower cervical segments to lumbar segments ) .

## Methods

A group of 129 cases with adult spinal tuberculosis ( from C3 to L5 segments ) were treated successfully via conservative anti-TB drugs or surgery and were followed up for at least 2 years. There were 70 male and 59 female patients, aging from 21 to 67 years old. Clinical and imaging data of these patients were retrospectively viewed by spine specialists from our institutions.

The data obtained from the enrolled patients were reviewed and discussed at several meetings by a total of 6 surgical spine experts from two affiliated centers of Chinese People's Liberation Army General Hospital. The experts polled for characteristics of spinal tuberculosis, which they considered to be pivotal in clinical judgment and decision-making for current treatment in order to provide a framework for a new functional spinal tuberculosis classification system. By consensus, the classification system was restricted to include: 1) the stability of spine, 2) the severity of neurological deficit, 3) the efficacy of the anti-tuberculosis drug therapy, 4) flexibility to develop through future clinical research, 5) usefulness in prospective studies, and 6) the reproducibility.

After consensus was reached on the structure of the new classification system, 20 cases among the included patients were reviewed again by members of our institution to ensure the elimination of any remaining apparent limitations and to understand the initial reliability and validity of the new classification for spinal tuberculosis.

## Results

Among all 129 cases in this study, 35 cases were cured under conservative treatment, while 11 cases underwent surgical treatment ultimately after failure of conservative treatment and the left 83 cases

underwent anterior, posterior or combined surgical approach at the first visit. The detail of patients were shown in Table 1. Severity scoring system is based on the retrospective analysis of the 129 patients who were treated medically and surgically. Three major variables were identified critical to clinical decision-making in spinal tuberculosis:

1. The stability of spinal infectious segments, which includes the kyphosis angle and “risk factors”, determined by imaging appearance;
2. Neurologic status, which includes the cause of the spinal cord injury and the severity of spinal cord deficit
3. The efficacy of the anti-tuberculosis drug therapy. These three main characteristics were thought to be largely independent predictors of clinical outcome. Within each of the three categories, subgroups were identified and arranged from least to most significant. The three major components of the severity scoring system and their subgroups are described as follows.

Table 1  
Characteristics of patients

	Conservative treatment	Surgical treatment	Changing treatment <sup>□</sup>
Cases (No.)	35	83	11
Location of the lesion (No.)			
lower cervical segment	9	15	2
cervical-thoracic segment	0	2	0
thoracic segment	15	31	4
thoracolumbar junction	1	8	0
lumbar segment	10	19	5
lumbosacral segment	0	8	0
Neurological status (No.)			
AIS A, B or C	0	13	0
AIS D or radicular pain	8	26	4
Normal	27	44	7
Psoas abscess (No.)	12	21	1
<sup>□</sup> Changing treatment: cases underwent surgical treatment ultimately after failure of conservative treatment			

### Stability of spinal tuberculosis:

Two elements including kyphosis angle and “risk factors” for progression of kyphosis were both used to assess the stability of spinal tuberculosis (Table 2).

Table 2  
Assessing the stability of infectious vertebral segments

Kyphosis angle	Risk factors <sup>□</sup>	Points
< 30°	No	2
> 30°	No	3
< 30°	Yes	4
> 30°	Yes	5

<sup>□</sup>Risk factors: it includes 1) accumulative loss of vertebral bodies above 0.75 or collapse of vertebral segment, 2) focus at cervical-thoracic, thoracolumbar junction or lumbosacral segment 3) spondylolysis, 4) retropulsion, and 5) lateral translation. Occurrence of any one of the above-mentioned “risk factors” can be considered as “Yes”.

1. Kyphosis angle was calculated on the lateral X-ray—two lines are drawn, one paralleling the superior surface of the first vertebra cephalic to the destructive segments and the other paralleling the inferior surface of the first vertebra caudal to the destructive segments. Kyphosis angle of 30° is defined as a cutoff value for the subgroup division.
2. “Risk factors” include (Figure 1): 1) accumulative loss of vertebral bodies above 0.75 or collapse of vertebral segment, 2) focus at cervical-thoracic, thoracolumbar junction or lumbosacral segment 3) spondylolysis, 4) retropulsion, and 5) lateral translation. Occurrence of any one of the above-mentioned “risk factors” can be considered as “Yes”. The “risk factors” for progression of kyphosis is determined by careful review of radiographic studies to determine the pattern of anatomic destruction. In most cases, this requires integration of information from plain radiographs, CT-scan, and MRI. The vertebral segment is included in the description of the infectious morphology.

## Neurologic Status

In assessing neurologic status, both neurologic function and mechanical compression of spinal cord or nerve root play an important role in the choice of treatment (Table 3). Thus, it comprises one of the three main characteristics in this classification algorithm.

Table 3  
Evaluation of Neurologic Status

Neurological deficit (AIS) grading	Mechanical compression	Points
AIS A, B or C	---	4
AIS D or radicular pain	Kyphotic vertebral body, sequestrum or extensive multi-segment epidural abscess	3
AIS D or radicular pain	Tubercular debris or (and) caseous tissue	2
AIS D or radicular pain	Epidural abscess involved single segment	1
Normal	---	0

Currently, there is still no particular evaluation system about spinal cord injury used for neurological deficit of spinal tuberculosis. According to the literature report, American Spinal Injury Association (ASIA) impairment scale (AIS) grade is commonly used in evaluating the neurological status of spinal tuberculosis<sup>7,10,11</sup>. Hence, to facilitate communication and application, the neurologic status in this study is evaluated using American Spinal Injury AIS grade and radicular pain.

Mechanical compression of the cord includes: 1) kyphosis vertebral body, sequestrum and extensive multi-segment epidural abscess; 2) tubercular debris and caseous tissue; 3) single-segment epidural abscess. It requires integration of information from CT-scan and MRI to determine the characteristics of mechanical compression.

### Anti-TB Drugs

Effective anti-TB drugs are the mainstay of treatment for spinal tuberculosis. Many reports have shown that conservative therapy alone can achieve excellent results in patients without severe kyphosis deformity or paraplegia<sup>12,13</sup>. Thus, drug therapy is important to spinal classification and treatment algorithms. Multidrug anti-tubercular treatment is essential with the first-line drugs including isoniazid, rifampicin, pyrazinamide, ethambutol, or streptomycin. It should be noted that evaluating the efficiency of anti-TB drugs in this study include not only the function of anti-TB bacillus, but the improvement in neurological status and the progression of kyphosis.

Efficacy of anti-TB drugs is categorized as “improvement”, “nonresponse” and “deterioration” (Table 4). This assessment can be made from carefully comparing the patients’ clinical data at the first visit (before using anti-TB drugs) with those following for at least 2–4 weeks later (after using anti-TB drugs for at least 2–4 weeks). Patients’ clinical data includes symptoms, physical examination, erythrocyte sedimentation rate (ESR), signs of plain film, CT, and MRI images.

Table 4  
Evaluation of anti-tubercular drug therapy  
efficacy

First visiting	Follow-up	Points
Improvement	Improvement	1
--	Nonresponse	2
--	Deterioration	3

The key points of “improvement” are: 1) the amelioration of neurological status, 2) the gradual absorption of pathological tissue compressing the spinal cord, 3) no change or even decrease of kyphosis angle, 4) gradual decrease of ESR.

The “nonresponse” is defined as: 1) no evidences of neurological status improvement, 2) no absorption of the pathological tissue compressing the spinal cord, 3) no decrease or even increase of patient pain and (or) ESR. The “nonresponse” is the evaluation applied at the time of follow-up for at least 2–4 weeks.

The “deterioration” is defined as the worse of neurological deficit or (and) the increase of kyphosis angle above 10° according to the clinical signs and imaging data at any follow-up time comparing to previous data.

### The severity scoring system for spinal TB

A comprehensive severity scoring system is calculated based on the three major characteristics to assist in determining treatment. Each subgroup in the three main variables has a numerical value associated with it in order to provide a comprehensive severity score. One to five points (1 point considered as least severe; 5 points as most severe) are assigned to reflect the degree of severity of the spinal mechanical stability or neurologic deficit. For the cases with multiple contiguous or noncontiguous infectious segments of spine, only the most severely involved segment is scored.

1. Cases with kyphosis angle  $<30^\circ$  but without signs of “risk factors” for progression of kyphosis are assigned as 2 points. Cases with kyphosis angle  $<30^\circ$  and signs of “risk factors” are assigned as 4 points. The kyphosis angle  $>30^\circ$  without signs of “risk factors” is assigned 3 points, while the kyphosis angle  $>30^\circ$  with signs of “risk factors” is assigned 5 points (Table 2).
2. A patient with an intact neurologic examination is assigned 0 point. AIS D and (or) radicular pain caused by single-segment epidural abscess compression is given 1 point; AIS D caused by the mechanical compression of tubercular debris and caseous tissue is assigned a score of 2 points, while caused by kyphotic vertebral body, sequestrum or (and) extensive multi-segment epidural abscess is assigned 3 points. AIS A, B or C is given 4 points (Table 3).
3. “Improvement” (follow up for at least two weeks) is assigned 1 point. The “nonresponse” is assigned 2 points, while the “deterioration” is assigned 3 points (Table 4).

## How to apply this severity scoring system

1. A comprehensive severity score of 4 or less suggests a conservative treatment that includes essential anti-TB drugs, wearing brace, etc.
2. While a total score of 6 or more should consider surgical intervention.
3. A score of 5 might be treated either conservatively or surgically.

It should be clear that when patients visit for the first time, the anti-TB treatment is valid by default, that is, the subgroup (“Improvement”) score is 1 point (Table 4). When doctors finished evaluating a patient with spinal TB according to the severity scoring system for the first time, if the total score was assigned 5 or less ( $5 \text{ or } \leq 4$ ) and the conservative treatment was selected, follow-up should be required to be performed every 2-4 weeks. At the time of follow-up, it is necessary to re-evaluate cases according to the severity scoring system. Examples to illustrate the application of the severity scoring system are listed in Figure 2-12.

## Discussion

There are quite few classifications concerning spinal TB that has attempted to objectify infectious patterns and prognosis<sup>2-5,7,14,15</sup>. Among these reported classification schemes, experts experienced difficulties in reaching consensus on how to best represent these complicated spinal TB patterns. In the last decades, Gulhane Askeri Tip Akademisi (GATA) classification<sup>16</sup> of spinal TB was not used extensively since it did not contain the posterior spinal TB or other atypical spinal TB, and neurologic deficit was not always the indication for surgery<sup>14</sup>. Other classifications to develop treatment strategies were either unilaterally based on surgical protocols, or solely based on lesion sites or the grading of paraplegia. Some of these may be outdated with the further understanding of spinal TB treatment and new development of internal fixation of spine. The resulting confusion not only plagues spine surgeons, but also casts a shadow on the education of medical students, clinical and research fellows.

The kyphosis deformity is a serious and common complication of spinal TB. Severe kyphosis can lead to late-onset paraplegia and dysfunction of lung, which could be avoided through early surgical correction of the kyphosis<sup>17</sup>. In the cases with kyphosis angle less than  $30^\circ$  in adults, no additional progression will occur after successful conservative treatment<sup>18</sup>. Another study with a 10-year follow-up shows that when the kyphosis deformity is above  $30^\circ$ , conservative treatment can still lead to malformation with the angle eventually reaching  $50-73^\circ$ <sup>19</sup>. This indicates that the development of malformations is more likely to occur with kyphosis above  $30^\circ$ <sup>20</sup>. Based on these evidences reported from literatures, kyphosis angle above or below  $30^\circ$  is considered as an important element to predict the progression of deformity, furthermore as an important component of the severity scoring system .

However, it is not comprehensive to assess the final malformation solely based on the kyphosis angle. From cases in our study, although many have a kyphosis angle less than  $30^\circ$ , some of them still have high risks for severe malformation after cure due to lordosis at cervical and lumbar spine and the

relatively stable structure of the rib cage at thoracic segments. Thus, it is necessary to consider a more reliable method of predicting kyphosis progression in addition to the kyphosis angle. Unfortunately, there is still no single reliable standard for predicting the development of kyphosis. Singh R et al.<sup>21</sup> found that Rajasekaran's formula for predicting malformation based on vertebral height loss could not predict the final progression of kyphosis. Jutte P et al.<sup>22</sup> enrolled patients with malformations less than 40°; predicted kyphosis based on the proportion of anterior and posterior height loss of the vertebral body and the location of the lesion and found that the positive rate was only 38%. Therefore, the severity scoring system is undertaken with these limitations in mind and considers not only kyphosis angle but "risk factors" (Table 2) to assess the severity of vertebral segment destruction. Part of these "risk factors" are referred to the description by Rajasekaran S<sup>15</sup>.

Neurological dysfunction is another severe complication of spinal tuberculosis. There has been controversy in the treatment of spinal TB with neurological impairment. Some scholars suggest that surgical treatment should be performed when neurological dysfunction presents<sup>23</sup>. However, other reports indicate that conservative treatment can be effective when neurologic deficit is no less than AIS D with mechanical compression originating from TB abscess or necrotic tissue<sup>24 25</sup>. Nevertheless, severe neurological deficit (AIS A, B or C) with mechanical compression originating from vertebral body, sequestrum extensive multi-segment epidural abscess or (and) necrotic intervertebral disc tissue is associated with poor prognosis when conservative treatment is performed<sup>10,14,26-28</sup>. Therefore, based on our clinical treatment experience concerning neurological dysfunction, both characters that compress spinal cord or nerve and the severity of neurological dysfunction should be assessed to develop a reasonable treatment plan.

It should be emphasized that spinal TB is an infectious disease. Although surgery can solve the complications caused by TB, anti-TB drugs are still the cornerstone of successful treatment. Therefore, we believe that the therapeutic effect of TB drugs should not be neglected in the classification of spinal TB. In addition, score systems of other spinal diseases require only one-time scoring at presentation. However, spinal TB patients undergo a long process of anti-TB drugs treatment. Therefore, this classification system requires repeatedly evaluating patients who receive conservative treatment during follow-up in order to timely adjust treatment options.

Though the classification system above mentioned objectifies the patterns of spinal TB and helps to direct management, a variety of other clinical considerations can also have a significant impact on treatment. Therefore, it is necessary to consider many different factors before blindly acting on a comprehensive severity score of spinal TB. Multiple clinical factors may lead patients who otherwise require surgery according to the severity scoring system to non-surgical and vice versa. These factors include pulmonary TB, drug-resistant TB, multiple drug-resistant TB, extensive drug-resistant tuberculosis (XDR-TB) and patients with AIDS, patients' age, and even general health, etc. The impact of these influencing factors on guiding treatment decisions cannot be objectified but must be considered when weighing the benefits of various treatment as a whole. In the same setting, a surgeon's experience with a

given surgical approach cannot be superseded by the principles of surgical approach mentioned above, because different approaches have been proved successfully to treat spinal TB <sup>29</sup>.

## Study Limitations

There still exist some limitations in this classification system. Firstly, the system is based on the retrospective study and experts' experience; hence multi-center and prospective studies are needed to further validate this classification system. Secondly, further estimation of intra-observer and inter-observer reliability is required to help objectively define how the severity scoring system will perform in practice.

## Conclusions

The severity scoring system stems from abundant clinical experience and comprehensively takes into account the severity of spinal instability, neurological dysfunction and efficacy of anti-TB drugs. It applies anticipated outcomes to recognize the spinal TB patterns through its numerical weighting system to guide the treatment plan. To our knowledge, no classification system published has integrated treatment algorithms for patients with spinal TB. We believe that the classification scheme and severity score can be useful to guide clinical management. The severity scoring system is suited for spinal TB with different anatomical features, lesions locating at lower cervical, thoracic and lumbar spine but not the atlantoaxial segments. It is also suitable for guiding rare spine attachment TB. We hope that the severity scoring system will help to create a language common for those who treat spinal TB to promote efficient and reliable communication.

## Abbreviations

TB

tuberculosis

ASIA

American Spinal Injury Association

AIS

American Spinal Injury Association Impairment Scale

ESR

erythrocyte sedimentation rate

GATA

Gulhane Askeri Tip Akademisi

XDR-TB

extensive drug-resistant tuberculosis

## Declarations

Ethics approval and consent to participate—our research is a retrospective study, which used medical records obtained from patients' imaging data and clinical data. Thus, the ethical approval is exempted from the Ethical Committee of our institutions.

Consent for publication—we can use your institutional consent form.

Availability of data and materials: the datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: the authors declare that they have no competing interests" in this section.

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Authors' contributions: Xuesong Zhang has made contribution to the conception and design of the work; Qi Wang, Wenhao Hu and Fanqi Hu have made contribution to the acquisition, analysis, Litao Li, Liaobo Luo, Yan Wang, Yuanzheng Ma and Xuesong Zhang have made contribution to interpretation of data; Xuesong Zhang have drafted the work or substantively revised ; Qi Wang was a major contributor in writing the manuscript. All authors read and approved the final manuscript

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## Figures

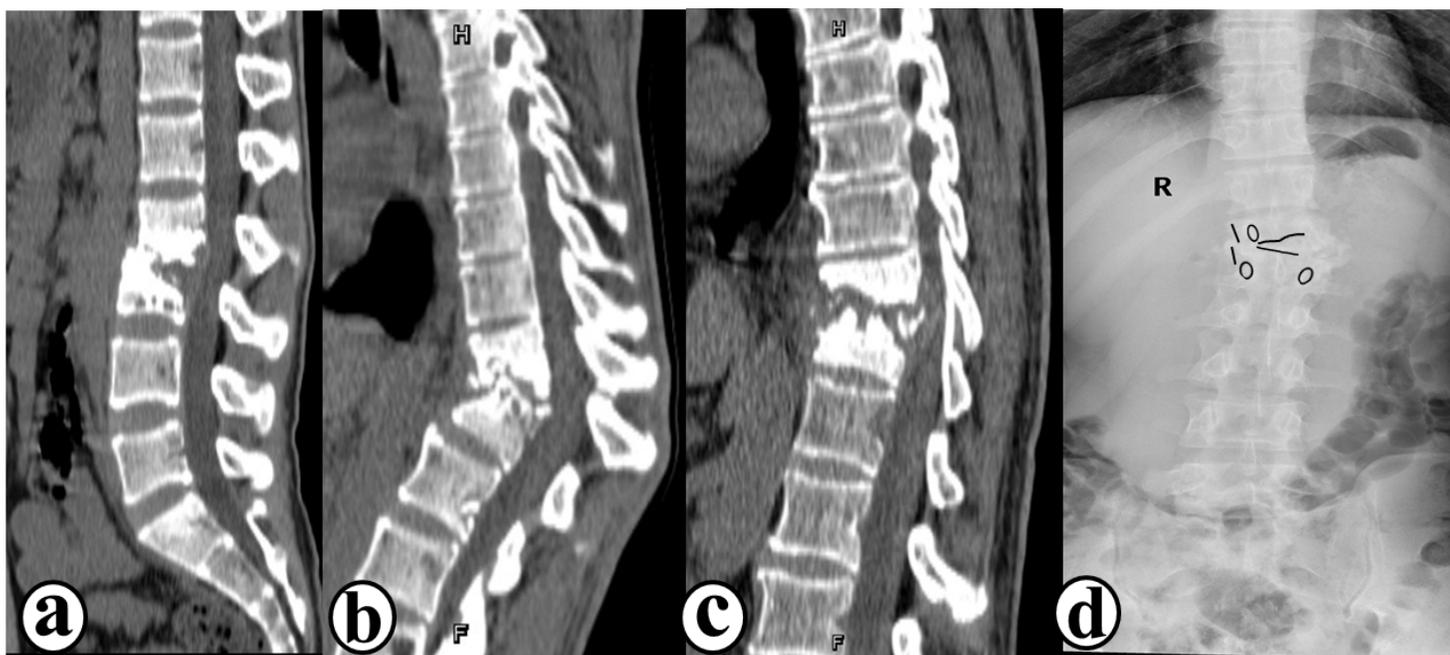
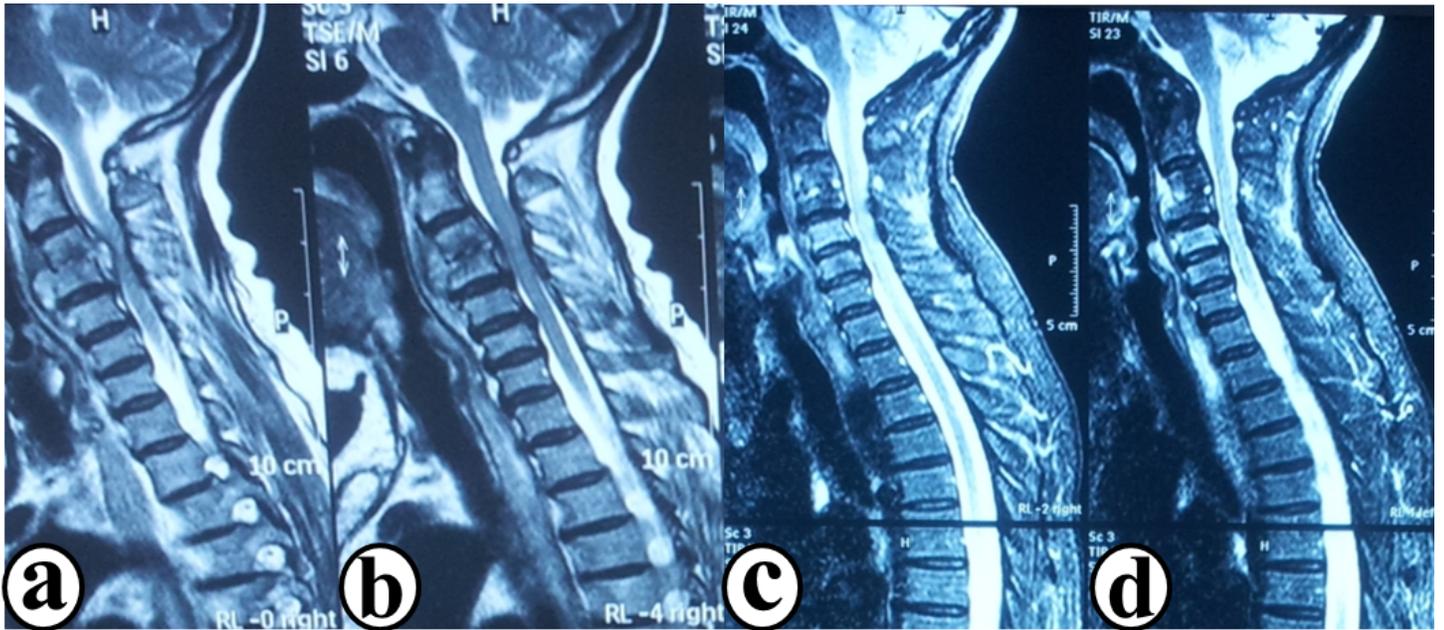


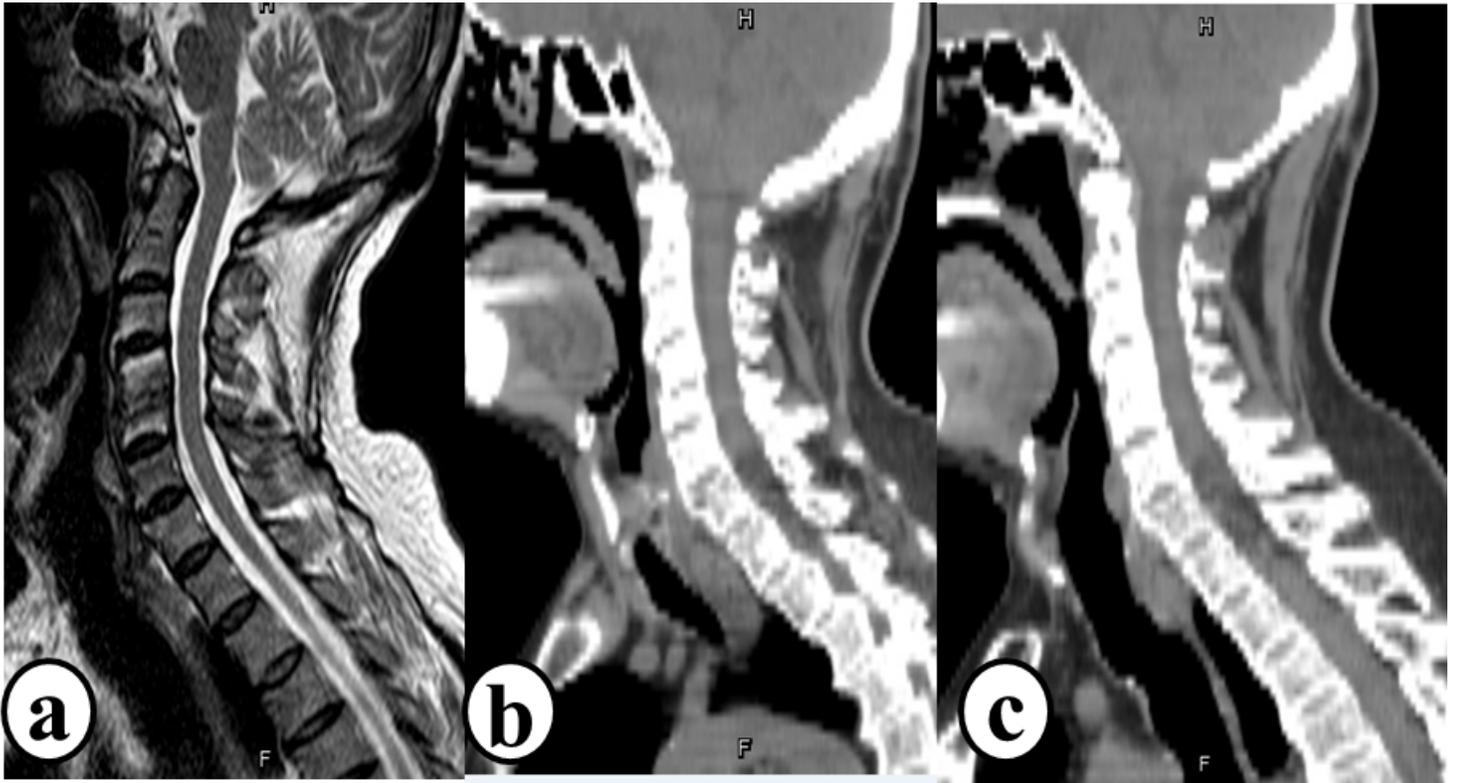
Figure 1

“Risk factors” for progression of kyphosis from radiological signs. a. retropulsion, b. spondylolysis, c. accumulative loss of more than 0.75 vertebral bodies or collapse, d. lateral translation.



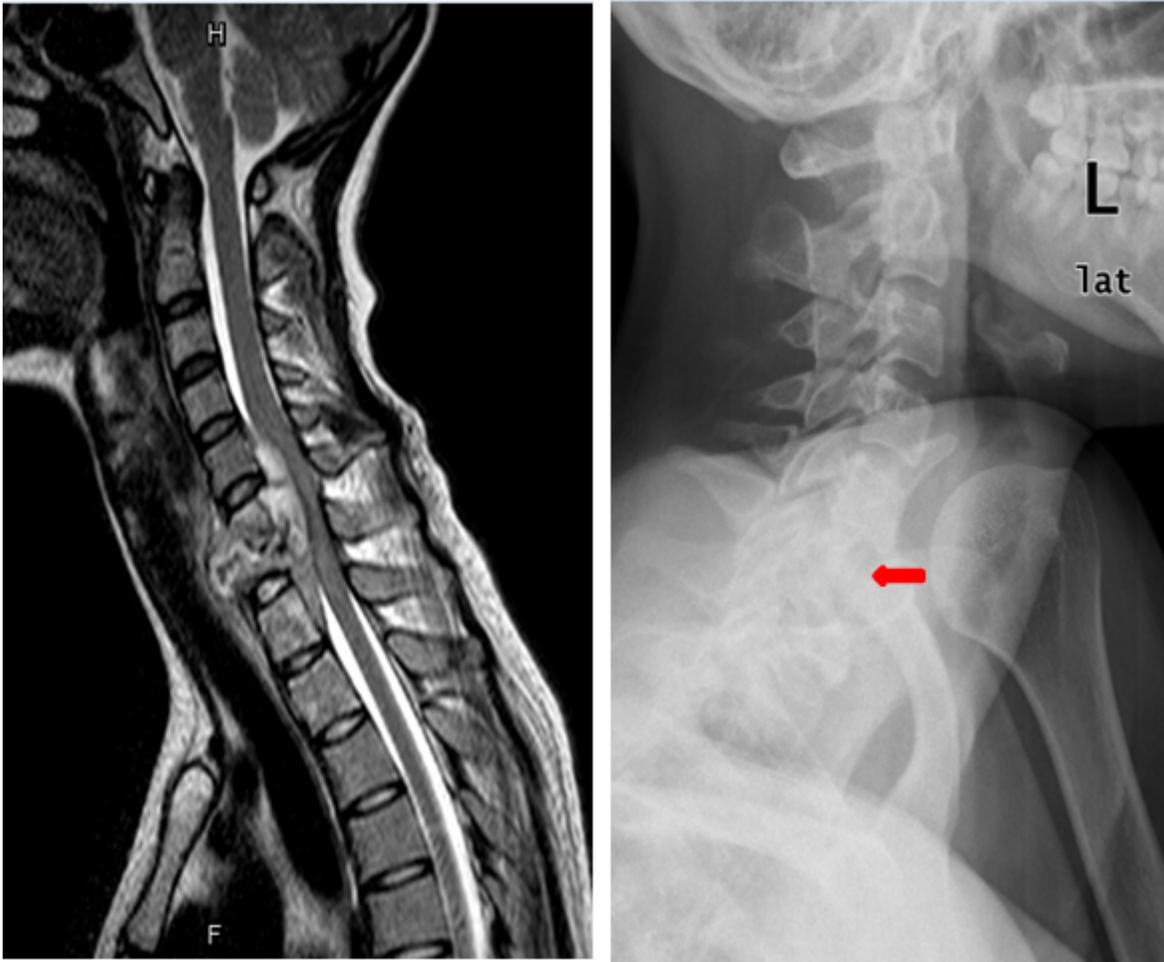
**Figure 2**

(a, b) A spinal tuberculosis in a patient with neurological deficit (AIS D). Kyphosis angle  $< 30^\circ$  and without “risk factors” of progression at C3-4 segment (2 points), AIS D and mechanical compression of spinal cord is epidural abscess (1 point), and effective anti-tuberculosis drugs (1 point) gives 4 total points; thus, the treatment recommendation is conservative treatment. (c, d) Four weeks later, re-evaluating according to STCS system was done, the kyphosis angle increased less than  $10^\circ$  and neurological deficit was improved after anti-tuberculosis drugs treatment (1 point), hence the total points changed from 4 to 3, conservative treatment is still recommended.



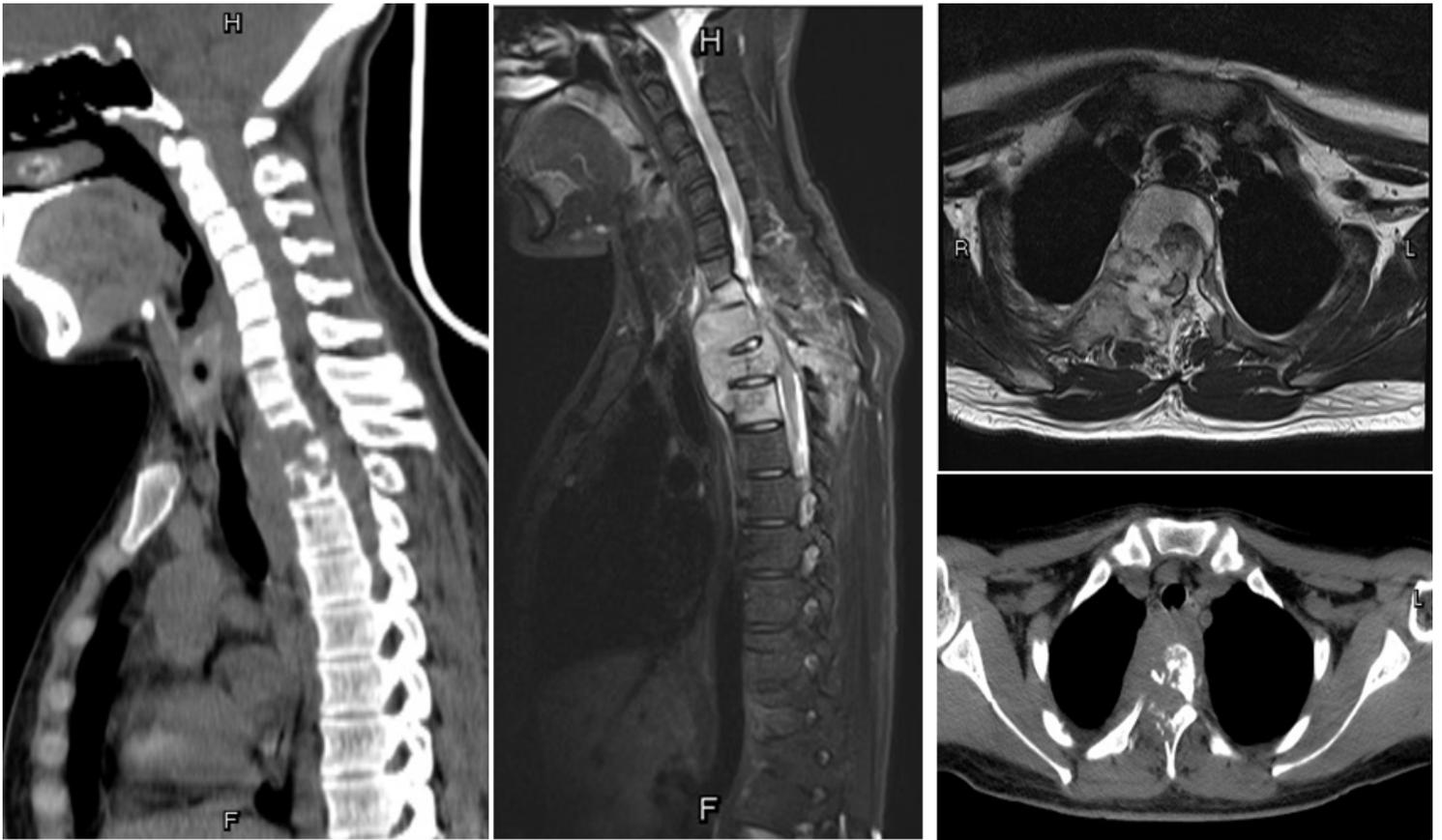
**Figure 3**

(a, b) A cervical tuberculosis in a patient without neurological deficit (0 point), Kyphosis angle  $< 30^\circ$  and without "risk factors" of progression at C4-5 segment (2 points), and effective anti-tuberculosis drugs (1 points) gives 3 total points; thus, the treatment recommendation is surgery. (c) one year later, the patient was cured.



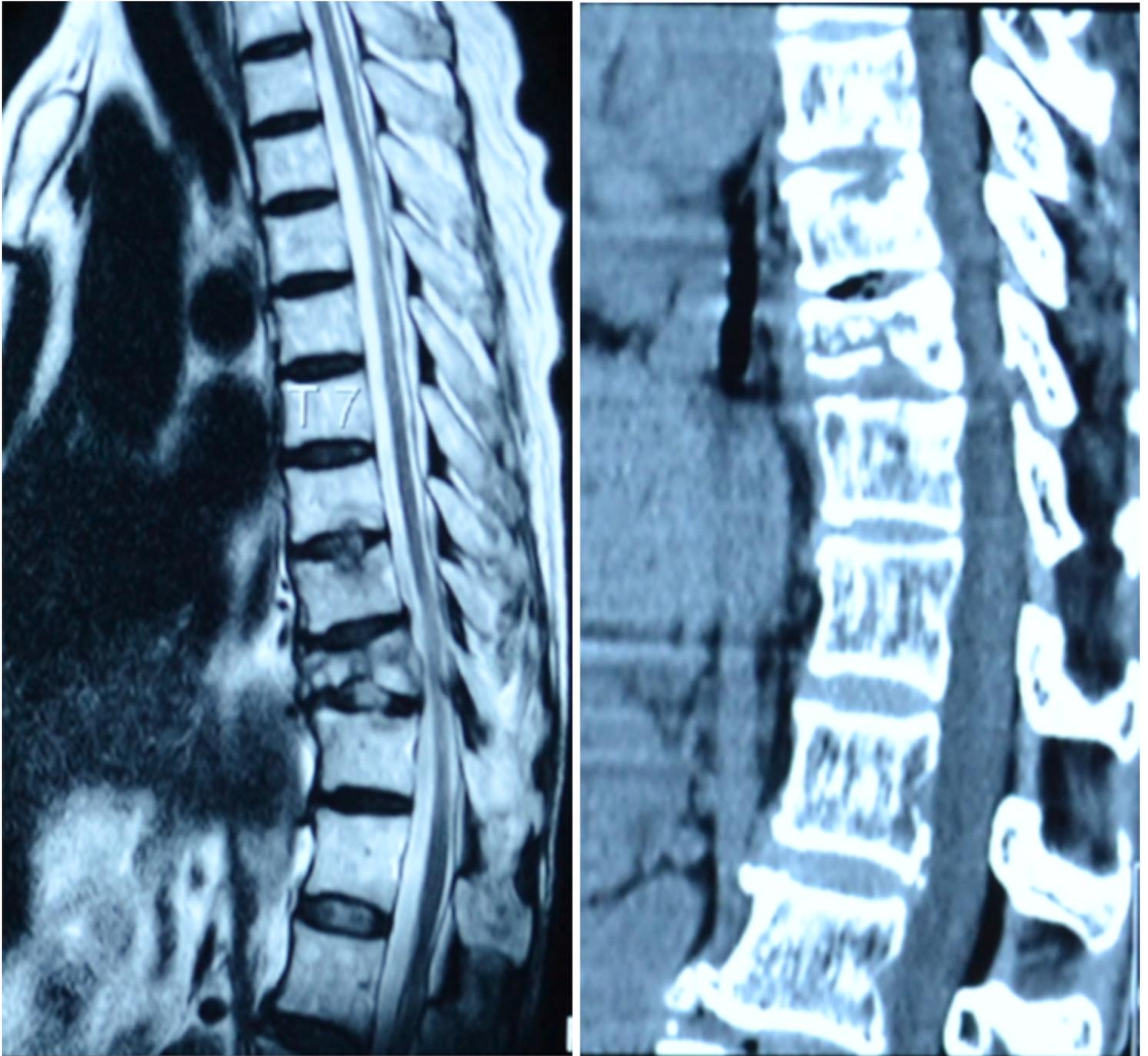
**Figure 4**

A cervical tuberculosis in a patient .Kyphosis angle $<30^{\circ}$ and with “risk factors” of progression at C6-7 segment (4 points),because of C6 vertebra loss more than 0.75 vertebral bodies (Red Arrow), AIS C (4 point), and effective anti-tuberculosis drugs (1 points). All above gives 9 total points; thus, the treatment recommendation is surgery.



**Figure 5**

A cervical-thoracic tuberculosis in a patient. Kyphosis angle  $< 30^\circ$  with “risk factors of progression” because the lesion located at cervical-thoracic segments (4 points), AIS C (4 points), and effective anti-tuberculosis drugs (1 points), all these give 9 total points; thus, the treatment recommendation is surgery.



**Figure 6**

. A patient with tuberculosis at thoracic segments. Kyphosis angle  $< 30^\circ$  without “risk factors of progression” (2 points), normal neurological function (0 point), and effective anti-tuberculosis drugs (1 point) gives 3 total points; thus, the treatment recommendation is conservative treatment.



**Figure 7**

(a, b) A patient with neurological deficit (AIS D). Kyphosis angle  $>30^\circ$  with “risk factors of progression” because infectious segment collapse (5 points), AIS D and (c, d) mechanical compression is sequestrum (3 points), and effective anti-tuberculosis drugs (1 points) , all these give 9 total points; thus, the treatment recommendation is surgery.



**Figure 8**

(a, b) A spinal tuberculosis in a patient with neurological deficit (AIS D). Kyphosis angle  $< 30^\circ$  without “risk factors of progression” (2 points), AIS D and mechanical compression is multi-segment epidural abscess (3 points), and effective anti-tuberculosis drugs (1 point). The point total is 6; thus, the treatment recommendation is surgery.



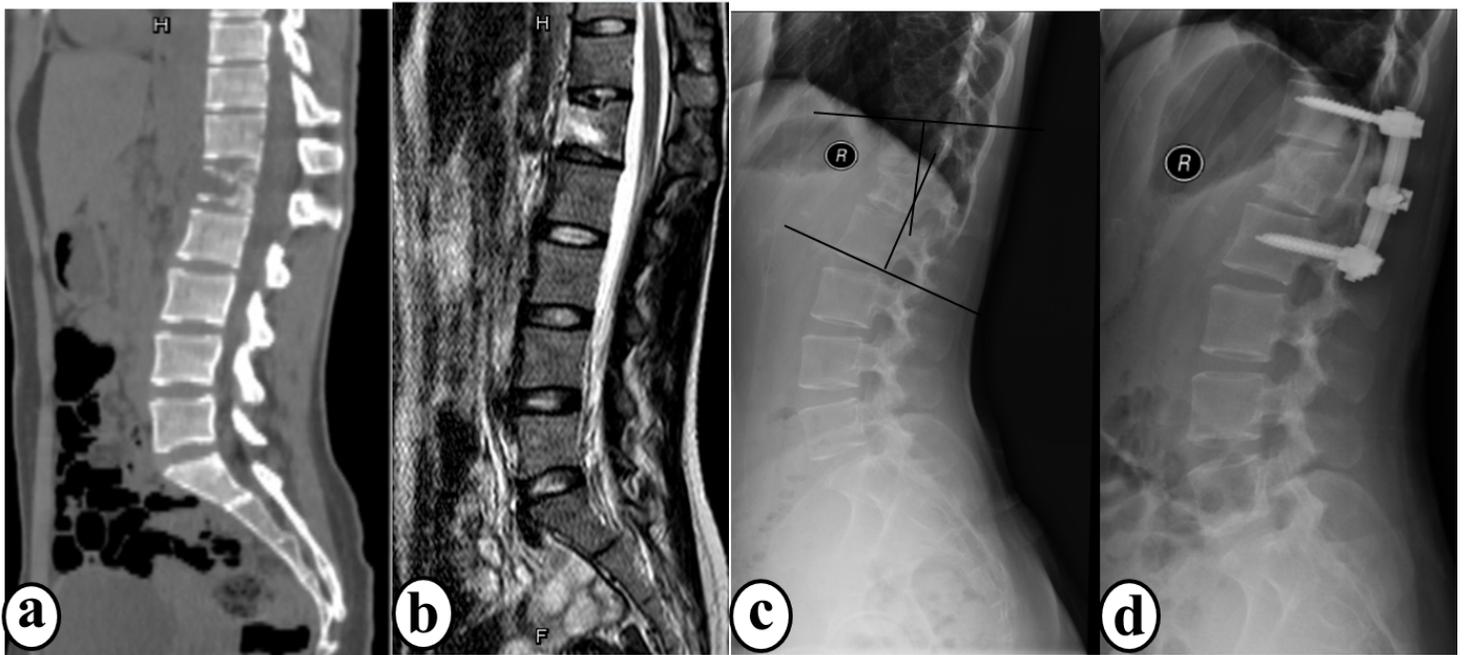
**Figure 9**

A patient without neurological deficit. Kyphosis angle  $>30^\circ$  without “risk factors of progression” (5 points), normal neurological function (0 points), and effective anti-tuberculosis drugs (1 points) gives 6 total points; thus, the treatment recommendation is surgery.



**Figure 10**

A spinal tuberculosis in a patient without neurological deficit. Kyphosis angle  $>30^\circ$  with “risk factors of progression” because the lesion located thoracolumbar junction and collapse of vertebral segment (5 points), normal neurological function (0 points), and effective anti-tuberculosis drugs (1 points) gives 6 total points; thus surgery is recommended.



**Figure 11**

(a, b) A spinal tuberculosis in a patient without neurological deficit. Kyphosis angle  $< 30^\circ$  with “risk factors of progression” because the lesion located thoracolumbar junction (4 points), normal neurological function (0 points), and effective anti-tuberculosis drugs (1 points) gives 5 total points; thus, conservative treatment is chosen. (c, d) However after 8 weeks, re-evaluating according to STCS system was done, the kyphosis angle increased more than  $10^\circ$ , “deterioration” after anti-tuberculosis drugs treatment (3 points), hence the total points changed from 5 to 7, surgery is recommended.



**Figure 12**

A spinal tuberculosis in a patient with radicular pain. Kyphosis angle  $< 30^\circ$  with “risk factors of progression” because infectious segment accumulatively lose more than 0.75 percent of vertebrae (4

points), radicular pain and mechanical compression is tubercular debris and caseous tissue (2 points), and effective anti-tuberculosis drugs (1 points) , all these give 7 total points; thus, the treatment recommendation is surgery.