Reply to comment on Wang et al.: Single-stage posterior instrumentation and anterior debridement for active tuberculosis of the thoracic and lumbar spine with kyphotic deformity

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Published online: 7 June 2013
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We would like to thank Dr. Sudhir Mahapatra and his colleagues for their thoughtful comments regarding our recent publication. Indeed, we agree with Rajasekaran et al. [1] that there is some correlation between vertebral body loss (VBL) and the angle of kyphosis, especially for cases not serious enough to require surgical treatment. However, we have found that there are several specific conditions, as below, in which the formula $Y=5.5+30.5VBL$ cannot always be used to predict the actual final angle of the gibbus deformity.

First of all, the focus of spinal tuberculosis can be located centrally or on the superior or inferior edge of a vertebra. When the edge of a vertebra is involved, especially the inferior end plate of the upper vertebra and the superior end plate of the lower vertebra, the intervertebral disc is usually damaged and collapsed, lending to contact and fusion of the adjacent two remnant vertebrae. This kyphotic angle can be well predicted by using the formula presented above. In an unusual situation, with the focus located more centrally, there is more damage and deterioration of the whole body. Then, the upper column of the spine will rotate evidently, creating a more severe kyphotic angle (Fig. 1). We

believe that in this kind of situation, the formula cannot predict the kyphotic angle precisely, and is usually less than the actual kyphotic angle.

We also noticed that there were some location-related and segment-related differences in the change of the kyphotic angle. When the thoracolumbar segments (T10-L2) were involved by tuberculosis (Fig. 2), or when more than three thoracic segments were involved (Fig. 3), the kyphotic angle tended to be more serious. Jutte et al. [2] confirmed that the thoracolumbar location is another predictor although VBL is the most powerful one. In his study, the final angle could be predicted with a difference of less than $\pm 10^\circ$ in only 64 % of patients by applying the formula.

Last but not least, the predicted kyphotic angle was calculated presuming that antituberculous chemotherapy was administered as conservative treatment. Patients in previous studies all received chemotherapy treatment, so as to slow the progress of the kyphosis [3, 4]. In our study, most of the patients had not received any treatment until they presented to our clinic with serious back pain, neurological deficit, or a hump-shaped deformity. Our study also included children as young as six years old; Jain's study included patients 16–63 years old [3], and Kwon's study included

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Fig. 1 Thoracolumbar tuberculosis with T10-T12 involvement and T11 vertebra almost completely deteriorated. Vertebral body loss (VBL)=1.8. The predicted kyphotic angle turned out to be 60.4°, but the actual angle of gibbus deformity was 85°

patients 18–73 years [4]. However, young patients have been shown to progress more easily to severe kyphosis

[5]. This heterogeneity of cases may also lead to different results compared with previous studies.

Fig. 2 Thoracolumbar tuberculosis with T10-T12 involvement. Vertebral body loss (VBL)=0.9. The predicted kyphotic angle was 33.0°, while the actual angle was 43°

Fig. 3 Long segment thoracic tuberculosis with six vertebrae involved (T6–T11). Vertebral body loss (VBL)=1.2. The predicted kyphotic angle was 42.1°, and the actual was 71°

In conclusion, we have found that there are still some discrepancies in the values of predicted and actual observed kyphotic angle. This is also a reason why we measured both the data of VBL and the kyphotic angle.

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