Reviewer's comment on "The 'X-Factor' Index: a new parameter for the assessment of the adolescent idiopathic scoliosis correction" by Yuqing Sun et al. (ESJO-D-09-00493 R1)

Martin Krismer

Received: 19 July 2010 / Published online: 3 August 2010
© Springer-Verlag 2010

According to Luk et al. [1] the fulcrum bending radiograph can predict the magnitude of correction of idiopathic scoliosis. The fulcrum bending is a measure of the intrinsic properties of the scoliotic spine like fixed bony deformity of vertebrae, as well as flexibility of discs, thoracic cage, muscles, and ligaments. Correction depends on extrinsic factors: on instrumentation pattern, mobilisation technique, magnitude and sequence of applied forces and moments, as well as on positioning of the patient. Furthermore, we can expect some random variation between fulcrum bending Cobb angles and postoperative Cobb angles. According to equation 7 the authors have defined the X-Factor Index as the difference between the fulcrum bending angle and the postoperative Cobb angle, divided by a factor indicating flexibility of the curve. The dividend (fulcrum bending angle minus the postoperative Cobb angle) depends on the extrinsic factors as well as on random variation, the divisor (equation 4) is an expression of the intrinsic factors (and of the performance of the fulcrum bending radiograph).

An example will demonstrate how the X-Factor Index (XFI) is responding to variation of the fulcrum angle. Let us assume the preoperative Cobb angle be 50° , and the postoperative Cobb angle be 20° . The resulting X-Factor is 0%, if the fulcrum bending is 20° (same correction obtained by fulcrum bending and postoperatively), 25% with a fulcrum bending angle of 30° , 100% with 40° , and 250% with 45° , respectively. With a 50° fulcrum bending angle, no X-factor can be obtained because of division by zero. If the preoperative angle be 50° , the postoperative 20° , and the fulcrum angle 10° (final correction worse than

fulcrum bending), the X-Factor Index will get negative and would be -12.5% , and with a fulcrum angle of $0^\circ - 20\%$. Therefore, in a typical range of pre- and postoperative angles as well as fulcrum angles, the X-Factor Index provides reasonable results, but not in a linear correlation. If no correction can be obtained, the X-Factor Index will be infinite. If rigid and flexible curves are mixed in a sample of patients, the average may tend to extreme values.

The X-Factor Index is a quotient of extrinsic factors divided by intrinsic factors, with the intention to create a parameter to measure extrinsic factors. The original construct of Luk et al. to measure extrinsic factors, the Fulcrum Bending Correction Index (FBCI, equation 6), is comparable to the XFI, with a different dividend and the same divisor, the dividend being fulcrum bending angle minus the postoperative Cobb angle in the XFI, and the correction rate (preop – postop)/preop in the FBCI. In Luk et al. [2] the FBCI was almost the same for four different instrumentations. We do not know, whether the XFI reacts more than the FBCI to particular surgical techniques such as mobilisation of ribs, or the use of pedicle screws in every pedicle versus in "strategic" pedicles.

The authors recommend the X-Factor Index in order to compare between different surgical techniques. These extrinsic factors may be associated with the X-Factor Index in different and varying proportions. An analysis of variance can demonstrate the varying degree of impact of different techniques, but will need a much higher number of patients, bearing in mind the considerable variation in curve magnitude, curve extension and rigidity of idiopathic scoliotic curves. Such an analysis could not be addressed in the current study due to an entire sample of only 30 patients.

The X-Factor Index is presumably not a good indicator for surgical skill, but may be valuable as a construct to

M. Krismer (✉)
Department of Orthopaedics, Medical School, Anichstrasse 35,
6020 Innsbruck, Austria
e-mail: martin.krismer@uki.at

measure the impact of different surgical techniques. As the techniques vary often in a way, which is not communicated, because surgeons consider their personal technique as a matter of course, differences in reported X-Factor Index values may induce a search for the reasons explaining differences. Furthermore, the proportion of the effect of a surgical measure can be expressed as a proportion of the X-Factor.

Conclusion

The X-Factor Index may serve as a parameter to measure the impact of extrinsic factors (correction and mobilisation techniques) applied in scoliosis surgery. If no correction can be obtained, the parameter will be infinite, and in

extremely rigid curves the parameter will be extremely high, so that the average in a sample may be difficult to interpret. The potential of the X-Factor Index to express the influence of different surgical techniques on correction is hypothetical, and not yet proven.

References

1. Luk KD, Cheung KM, Lu DS, Leong JC (1998) Assessment of scoliosis correction in relation to flexibility using the fulcrum bending correction index. *Spine* 23:2303–2307
2. Luk KD, Lu DS, Cheung KM, Wong YW (2004) A prospective comparison of the coronal deformity correction in thoracic scoliosis using four different instrumentations and the fulcrum-bending radiograph. *Spine* 29:560–563