BALANCE AND FUSION LEVELS IN RIGHT SIDED THORACIC ADOLESCENT IDIOPATHIC SCOLIOSIS*

M. CANİKLİOĞLU MD. H. R. GÜNGÖR MD. M. KARAMEHMETOĞLU MD.
A. BAYMAN MD. Ş. TÜREL MD.

ABSTRACT :

To evaluate interactions between corrective forces applied by segmentary spinal systems and fusion levels along with coronal and sagittal balance, x ray radiographs of 126 scoliosis patients operated in SSK Istanbul Education Hospital IInd Orthopaedics and Traumatology Clinics between November 1990 and May 1995 were examined retrospectively. Except 20 patients with atypical or left sided curves, 106 right sided adolescent thoracic idiopathic scoliosis were classified according to King's criteria and patients with King Type II and Type III comprising almost 2/3 of the group were included in the study (66 patients). Of these 47 patients were reevaluated in December 1995 (9 boys, 38 girls, mean age 14.9 years). Preoperatively, average coronal thoracic Cobb angle was 52.4 and lumbar was 34.6 degrees (mean follow-up period 31.7 months). For 12 patients CD instrumentations patients MSS instrumentations were used postoperatively, average correction in coronal Cobb measurement for thoracic curves was 59.9% and for lumbar was 63.5%. King Type II and Type III scoliotic curves are evaluated separately, and further subgrouped in relation with lowest instrumented vertebra (LIV) relative to stable vertebrae (SV). Coronal decompensation was observed in 8 (36%) Type II patient, and 3 (12%) Type III patient.

Data obtained from this study showed us that Type II curves are more prone to decompensation than Type III curves. Lowest instrumentation level is not prognostic for postoperative decompensation. Patient based modifications are more raliable than strict guidelines for selection of distal fusion level since application of corrective forces to each segment at each sides is possible with posterior derotation systems. Only prognosis factor for Type II curves for postoperative decompensation is preoperative decompensation. Type II curves with preoperative decompensation are more prone to develop postoperative decompensation. Type III curves can be managed safely ending fusion at SV, and ending short of SV does not obviously results with decompensation but rather with adding on phenomena. Extension of fusion in Type III curves does cause detoriation of compensation but rather more effectively corrects coronal curve.

Key words: *Balance, Fusion Levels, Scoliosis Surgery.*

Imbalance may be defined as deviation of coronal or sagittal weightbearing axis, either clinically or radiographically. In the coronal plane, imbalance is related to central sacral line. In the sagital plane, imbalance is primarily displacement of axis in the anterior direction (2, 3, 4, 10, 12, 16, 19, 21). Since pure coronal or pure horizontal deformities are almost never seen because of the sagittal curvatures that exist physiologically, decompensation in two planes may occur in scoliosis (1, 2, 3, 12, 14, 21).

Patients may show significant decompensation without terribly large curves or patients may be compensated with a 100 degree curve. This is because human body adopts himself this pathologic condition by formation of secondary or compensatory curves. These compensatory curves develop both above the below the structural curve or curves. However, because the lumbar spine is more mobile and more efficient mechanically, it always provides a maximum secondary curve. Therefore significant decompensation may be seen with small single major lumbar or thoracolumbar curves. So, for thoracic curves decompensation is a problem of scoliosis surgery rather than being a preoperative condition (4, 12, 21).

Coronal plane imbalance was not noted with Harrington instrumentation in idiopathic deformities. Sagittal plane imbalance was common in Harrington instrumentation in lumbar spine. With use of posterior derotation systems (PDS), the incidence of sagital plane imbalance and lumbar flat back syndrome has diminished. Thoracolumbar junctional kyphosis is the most common sagital plane imbalance problem with these instrumentation systems. Coronal plane decom-

* SSK Istanbul Education Hospital, IInd Orthopaedics and Traumatology Clinic, Istanbul - TURKEY

pensation is a complication peculiar to PDS. Many investigators have reported this problem with a wide speculation as to the etiology (1, 2, 5, 6, 7, 8, 10, 12, 13, 14, 15, 16, 17, 19, 21).

This study was undertaken for the purpose of determining the factors contributing postoperative decompensation of scoliotic patients with PDS in King Type II and II curves which are prone to postoperative decompensation and are compensated most of the time preoperatively.

MATERIALS AND METHODS

X ray radiographs of 126 adolescent idiopathic scoliosis patients operated in SSK Istanbul Edication Hospital IInd Orthopaedics and Traumatology Clinics between November 1990 and May 1995 were examined retrospectively. Twenty patients with lumbar, thoracolumbar or atypical thoracic curves were excluded and 106 curve patterns were classified according to King's classification. Of these 66 curve patterns were classified as King Type II and III comprising almost 2/3 of the series, and reevaluated in December 1995. Three patients due to insufficient preoperative radiographs, 2 patients due to left sided scoliosis, 1 patient due to exitus in early postoperative period, 1 patient due to combined anterior and posterior operation, and 12 patients due to lack of follow-up were excluded. Remaining 47 patients were included in the study.

Patients were evaluated preoperatively and maturity, balance (C7-intergluteal plumbline), shoulder asymmetry and pelvic tilt were recorded. The PA x-rays examined and a number of parameters were recorded. Cobb angles of both major and compensatory curves, radiological balance (C7-midsacral plumbline distance), upper and lowest instrumented vertebrae (LIV), stable vertebra (SV), neutral vertebra (NV), stable vertebra tilt (SVT), lowest instrumented vertebra tilt (LIVT), lumbosacral angle (LSA), apical vertebra rotation (AVR) (Nash-Moe technique), apical vertebra translation (AVT) (horizontal distance from the center of apical vertebrae to central sacral line), lowest instrumented vertebrae translation (LIVTR) were determined. Voluntary side bending radiographies were studied and flexibility indices (FI) were calculated. Lateral x-rays were used to obtain sagittal Cobb measurements (T5-T12, T10-L2, T10-T12, T12-L2, L1-L5). Sagital compensation was assessed by C7-promontorium distance. Postoperative and follow-up graphies were examined using same parameters described above. Acceptable coronal balance was defined as translation of C7-central sacral plumbline less than 10mm. Acceptable sagital compensation was defined as C7-promontorium plumbline lying less than 2 cm beyond promontorium.

RESULTS

Twenty-two King Type II and twenty-five King Type III patients were examined. Thirty-nine patients were female and nine patients were male (mean age 14.9). Mean follow-up period was 31.8 months (shortest 6 months, longest 61 months). Average thoracal Cobb angle was 52.4 and average lumbar Cobb angle was 34.6 degrees.

Postoperatively, 54.3% for thoracal 59.7% for lumbar correction was obtained in Type II curves. At follow-up 13.1% and 14.8% correction loss was detected for thoracal and lumbar curves, respectively. Preoperatively decompensation more than 10 mm was observed in 4 patients (3 to left, 2 to right). In the postoperative period decompensation observed in 7 patients (all to left). Of these 1 fusion ended at SV, 3 fusion ended beyond stable vertebra and junctional kyphosis region, 2 fusion ended 1 level proximal to lumbar end vertebra and 1 fusion including both curves. One of these patients with fusion distal to SV and junctional kyphosis region to L1 was improved at follow-up. The others remained same or worsened. Four of these patients was those with primarily decompensated curves. For the patients with primary compensation, hook pull-out in one patient, late infection in one, and proximal thoracic compansatory curve in the other patient was detected in the follow-up. There was no positive or negative correlation between postoperative decompensation and previously mentioned parameters, and either between lowest instrumentation level in relation to stable vertebra and postoperative decompensation. Only positive correlation was between preoperative decompensation and postoperative decompensation.

For King Type III curves 64.8% thoracal and 66.9% lumbar correction was obtained postoperatively. At follow-up 24.8% and 29.4% correction loss was detected for thoracal and lumbar curves, respectively. Preoperatively, more than 10 mm decompensation observed in 14 patients (all to right). Only two patients fused short of stable vertebra showed decompensation postoperatively but recompensation was detected at follow-up. At follow-up 3 patients showed decompensation. One was due to hook pull-out in proximal instrumentation region and other one was due to development of proximal compensatory curve. The third patient was the patient whose instrumentation stopped at SV but proximal to junctional kyphosis region (T12) and showed neurologic detoriation probably due to development of extreme junctional kyphosis. Removal of implants were performed to this patient and neurologic picture improved but decompensation was detected.

Preoperative average sagittal Cobb measurements for Type II curves at T5-T12 levels showed no difference with average follow-up sagittal Cobb measurements (28 degrees). Similar findings was observed for L1-L1 levels; –43 and –40 degrees for preoperative and follow-up, respectively. One of two patients whose instrumentation ended at T12 showed increased kyphosis at T10-T12 region but not T10-L2 region since just below kyphosis beginning of lordosis was detected. Distal instrumentation levels of other patients was beyond T12 and no complication was occurred regarding either junctional kyphosis region or lordotic segments. There was no detoriation of sagittal balance in operated Type II curves.

Preoperative average sagital Cobb measurements for Type III curves at T5-T12 levels showed improvement from 16.6 degrees to 27 degrees at follow-up. Average lordosis angle was also improved slightly from –37 degrees to –44 degrees. Of 14 patients whom distal fusion segment is proximal to L1, 6 patients showed more 5 degrees junctional kyphosis. One of these patients was the previously mentioned progressive late neurologic deficit patient and this patient did well with removal of implants and brace treatment. The other 5 patients required no active treatment.

DISCUSSION

In literature, most commonly, incorrect selection of fusion levels and correction of the thoracic curve to a degree to which the lumbar curve is unable to compensate are accused to be the possible causes of decompensation. There is little agreement among surgeons on levels of fusion. Improper selection of distal fusion levels, usually too short ignoring the lumbar curve, selection of fusion levels too short in proximal extend ignoring the high thoracic curve, failure to recognize sagital plane deformity particularly at the thoracolumbar junction, poor hook patterns particularly regarding force direction in coronal plane, ending a pattern on the apex either in coronal or sagital plane, no appreciation for axial changes on dynamic radiographs, and crankshaft phenomenon producing curve progression are all discussed for being possible causes of postoperative decompensation following PDS (1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19).

Neither of these factors are found to be responsible for postoperative decompensation in our series. In literature up to 70% decompensation was reported for Type II curves and it is said to be more susceptible to decompensation than other thoracic curves (2, 10, 16): This is also true for our series. There is 31.8% decompensation more than 10 mm in our series. Four of seven patients were primarily decompensated. In other 3 patients decompensation was due some other factor contributing to that. One of them showed infection and the other one was due to hook dislodgement. The third one was due to not extending proximal fusion level to T1 since T1 tilt was observed in not neutral but traction radiographs. There was no negative or positive correlation with postoperative decompensation and other parameters measured that are previously mentioned. The only correlation was between preoperative decompensation and postoperative decompensation. Since human body readily adopts himself to decompensated situation as it is in natural of scoliosis, this decompensation may be due to a disorder in body righting mechanisms of decompensated person. Therefore some general rules may be accepted for surgery of Type II patients but most of the time patient based modifications far more reliable for scoliosis surgeon to determine fusion levels and instrumentation pattern since with PDS it is possible apply corrective forces to each segment and to each site. For example, sharp angular deviations in junctional kyphosis region should alert scoliosis surgeon to avoid derotation maneuver and whether or not L1 is stable vertebra fusion should be extended to L1 with a reverse bend rod by applying distractive forces to convex site and compressive forces to concave site in distal fusion area; otherwise result will be inevitably instrumentation ended at apex of kyphos and progressive kyphosis.

Our results showed that Type III curves are easily managed ending fusion at short of stable vertebra, stable vertebra or distal to stable vertebra without causing significant decompensation. While ending fusion at short of stable vertebra causes adding on phenomena and correction loss at long term follow-up, ending fusion distal to stable vertebra more readily corrects coronal curve but sacrifies motion by fusing one or more segments. Sagital contours should be considered at this point and in any case of suspicion, surgeon should not hesitate to extend the distal level of fusion since there no gold standard to predict development of postoperative junctional kyphosis. Junctional kyphosis may develop in a patient without significant kyphosis at T10-L2 level, than measurements at T10-T12 and T12-L2 levels should seperately be done and in any case of sharp angular deviations in these two levels distal level of fusion should be extended.

CONCLUSION

Selective thoracic fusion guidelines are not strict guidelines and patient based modifications should always be done when using PDS. One should keep in mind that in preoperatively decompensated cases it is difficult to rebuild compensation especially for Type II curves.

Type III curves can be managed safely ending fusion at SV, and ending short of SV does not obviously results with decompensation but rather with adding on phenomena. Extending distal level of fusion more effectively corrects coronal curve.

Sagital plane should always be considered while selecting, distal level of fusion since junctional kyphosis is a common problem encountered with PDS.

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