Factors Influencing the Outcome of Arthrodesis for Congenital Kyphosis and Kyphoscoliosis

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Summary
Sixty-five patients with congenital kyphosis and kyphoscoliosis who underwent spinal arthrodesis are reviewed to determine the factors that influenced the outcome of arthrodesis. Mean follow up after surgery was 6 years and 6 months with all patients having a minimum of 2 years follow up. A satisfactory outcome, or a stable arthrodesis was defined as a loss of correction of less than 10 degrees from the time of surgery till review. An unsatisfactory outcome, or unstable arthrodesis was considered when there was more than 10 degree loss. Type of vertebral anomaly and type of arthrodesis procedure were significantly influenced stability of arthrodesis, whereas age when arthrodesis was performed and size of curve at surgery were not significantly related to stability of arthrodesis.

Key Words: Surgery, Kyphosis

Introduction
Congenital kyphosis and kyphoscoliosis are due to vertebral anomalies which are classified into 3 main groups. These are, Type 1 or failure of formation anomalies; Type 2 or failure of segmentation anomalies and Type 3 or the mixed type which is a combination of both Type 1 and Type 2. A fourth type, unclassified, when it is at times difficult to ascertain the vertebral anomaly on radiographs.

Each group has a different potential for progression, and hence a different requirement for surgery. These deformities are important because of the risk of injury to the neural structures if the sagittal plane deformity is allowed to progress. This is usually seen in the Type 1 and Type 3 vertebral anomalies. Spinal arthrodesis has been recommended as the treatment of choice for arresting the progression of the sagittal plane deformity.

The outcome of surgery for this condition has been reported variously between excellent and bad. This discrepancy in the result between centres is probably due to the low prevalence of the condition and lack of well constructed natural history studies on the condition. There exists, to the best of the author's knowledge, only one large outcome of surgery study for this condition. This present study is an attempt to identify the factors which influence the stability of arthrodesis for this condition.

Materials and Methods
Sixty-nine patients with congenital kyphosis were treated surgically at the Edinburgh Spinal Deformity Unit, Princess Margaret Rose Orthopaedic Hospital; between 1960 and 1996. These were from a cohort of 584 patients with congenital spinal deformities who...
were seen at the Unit during the same period, of which 112 had a congenital kyphosis or kyphoscoliosis. Sixty-five patients of the 69 who had a minimum of 2 years follow-up are reviewed for this study.

The sagittal plane deformities were measured using the modified Cobb method. This method utilises the angle generated between the perpendiculars of the most tilted cephalad and caudal vertebrae on the lateral radiograph. The measurements were made initially by the investigator and confirmed independently by the senior consultant of the Unit. In radiographs where there was a discrepancy, remeasurements were made and the final value was agreed upon by both.

Preoperative, immediate post operative, 1 year post operative, and final follow-up radiographs were evaluated for each subject. An unsatisfactory arthrodesis was assumed when there was a loss of 10 degrees or more on the final follow-up lateral radiograph, compared to the immediate post operative film. This was defined as 'an unstable arthrodesis'. A stable arthrodesis was
Five types of procedures were performed for the 65 patients. These were
a. prophylactic posterior arthrodesis before the age of 5 years (n = 11),
b. posterior arthrodesis and cast correction after the age of 5 years (n = 26),
c. posterior arthrodesis with instrumentation (n = 12),
d. combined anterior and posterior arthrodesis without instrumentation (n = 7) and,
e. combined anterior and posterior arthrodesis with instrumentation (n = 9).

The specific factors that were analysed were,
a. age at arthrodesis,
b. type of arthrodesis procedure,
c. vertebral type undergoing arthrodesis procedure, and
d. curve size at arthrodesis,
Table I
Immediate correction achieved after surgery in the different types of procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Mean Preoperative Curve (degrees)</th>
<th>Mean Postoperative Curve (degrees)</th>
<th>Mean Correction Achieved (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Posterior arthrodesis alone in patients under 5 years of age. ( N = 11 )</td>
<td>43</td>
<td>40</td>
<td>3</td>
</tr>
<tr>
<td>b. Posterior arthrodesis alone in patients over 5 years of age. ( N = 26 )</td>
<td>70</td>
<td>60</td>
<td>10</td>
</tr>
<tr>
<td>c. Posterior arthrodesis with instrumentation. ( N = 12 )</td>
<td>62</td>
<td>45</td>
<td>19</td>
</tr>
<tr>
<td>d. Anterior and posterior arthrodesis alone ( N = 7 )</td>
<td>97</td>
<td>79</td>
<td>18</td>
</tr>
<tr>
<td>e. Anterior and posterior arthrodesis with instrumentation. ( N = 9 )</td>
<td>90</td>
<td>58</td>
<td>32</td>
</tr>
</tbody>
</table>

Immediate correction achieved after surgery (Table I).

The largest immediate mean correction was seen in anterior and posterior arthrodesis with instrumentation. The least immediate correction was seen in patients who had a prophylactic arthrodesis before the age of 5 years. However, the patients who had a fusion before the age of 5 years did eventually improve as the fusion prevented the curves from progressing.

The effect of age at arthrodesis (Table II).

Arthrodesis done before the age of 5 years appeared to be more stable than an arthrodesis done after the age of 5 years. However, this was not statistically significant \( p = 0.574 \).
The effect of age at arthrodesis. Number of patients in relation to stability

<table>
<thead>
<tr>
<th>Age at procedure</th>
<th>Stable</th>
<th>Unstable</th>
<th>Total</th>
<th>Odds ratio for instability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 years</td>
<td>9</td>
<td>2</td>
<td>11</td>
<td>0.182</td>
</tr>
<tr>
<td>Over 5 years</td>
<td>35</td>
<td>19</td>
<td>54</td>
<td>0.352</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>21</td>
<td>65</td>
<td></td>
</tr>
</tbody>
</table>

$X^2 = 0.316, \ df = 1, \ p = 0.574$

The effect of type of arthrodesis procedure (Table III).

Posterior spinal arthrodesis with cast correction after the age of 5 years had the highest odds ratio for instability, followed by posterior arthrodesis with instrumentation, and prophylactic posterior arthrodesis before the age of 5 years. The most stable procedures were combined anterior and posterior arthrodesis with or without instrumentation ($p = 0.029$).

Effect of vertebral type undergoing arthrodesis (Table IV).

Unclassified anomalies had the highest instability rate, followed by Type 3, Type 1, and finally Type 2 vertebral anomalies ($p = 0.041$).

Effect of curve size at arthrodesis (Table V).

The best stability was seen in curves less than 40 degrees at time of arthrodesis. The worse stability was seen in curves between 40 and 80 degrees; whereas curves greater than 80 degrees appeared to have medium stability. This was not statistically significant ($p = 0.446$).

Discussion

There is no effective conservative treatment for congenital kyphosis or kyphoscoliosis. Arthrodesis of a potentially unstable curve, that is most likely to have deformity progression and ensuing neural compromise; prevents further progression of the curve. It is essential to understand the natural history of the curve if one is to make a good decision for arthrodesis.
In this study; type of vertebral anomaly, and type of arthrodesis procedure performed were significantly related to outcome of successful arthrodesis. Age at which arthrodesis was performed and size of curve at the time of procedure were not significantly related to outcome. Procedures which were done at an early age had the potential to correct a deformity gradually by altering the growth of the spine. Posterior arthrodesis in these patients allow gradual correction of the sagittal deformity by continued anterior spinal growth in the absence of significant posterior spinal growth. This was not seen to be statistically significant in this study probably due to the small number of patients available. An anterior procedure with or without a posterior arthrodesis had a better outcome because of the ability of the anterior spine with a 'strut' being able to resist sagittal deformity progression. Type 3 and Type 1 vertebral anomalies were most unstable because of the presence of a complete and intact vertebral end plate that participated in growth. Unclassified anomalies, seen to be most unstable, were probably Type 1 or Type 3 anomalies; but due to the severe curve at presentation a proper identification was not possible on the lateral radiograph. Curve size at surgery did not significantly affect the stability at maturity.

Based on the findings of this study, it is recommended that curves which have a high potential for progression are arthrodesed before the growth spurt. It is further recommended that curves due to Type 3, Type 1 and unclassified anomalies be treated with an anterior strut procedure in addition to the posterior arthrodesis; whereas Type 2 anomalies be treated by posterior arthrodesis alone without instrumentation.

**Conclusion**

Type of vertebral anomaly and type of arthrodesis procedure significantly influenced stability of arthrodesis, whereas age when arthrodesis was performed and size of curve at surgery did not significantly influence stability of arthrodesis.
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References


