ORIGINAL ARTICLE

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[1-3]. A fourth type, unclassified; when it is at times difficult to ascertain the vertebral anomaly on radiographs[4].

Each group has a different potential for progression, and hence a different requirement for surgery[5]. These deformities are important because of the risk of injury to the neural structures if the sagittal plane deformity is allowed to progress [6,7]. This is usually seen in the Type 1 and Type 3 vertebral anomalies [1,5]. Spinal arthrodesis has been recommended as the treatment of choice for arresting the progression of the sagittal plane deformity [1,2,5,7]. The outcome of surgery for this condition has been reported variously between excellent[8] and bad[6]. 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[9]. There exists, to the best of the author's knowledge, only one large outcome of surgery study for this condition[3]. 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

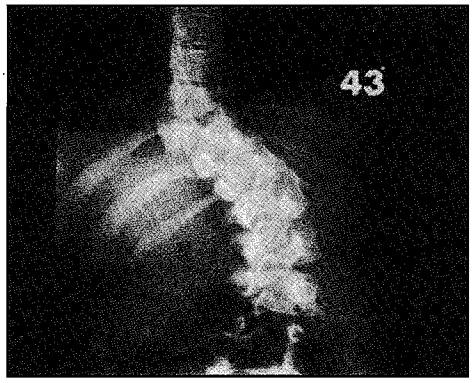

Figure 1A. A-P radiograph of patient with Type 3 vertebral anomaly at age 4 years and 1 month. The coronal curve is 43 degrees.

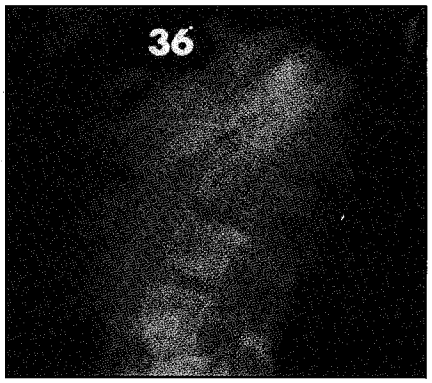

Figure 1B. Lateral radiograph of same patient at the same time with sagittal curve of 36 degrees.

Figure 2A. Pre operative A-P radiograph of patient at age 15 years and 1 month. The coronal curve has progressed to 77 degrees.

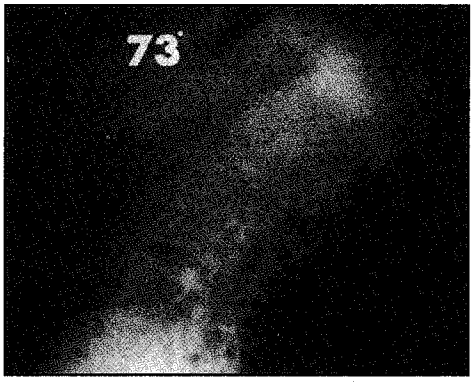

Figure 2B. Pre operative lateral radiograph shows the sagittal curve has progressed to 73 degrees.

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 caudad 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

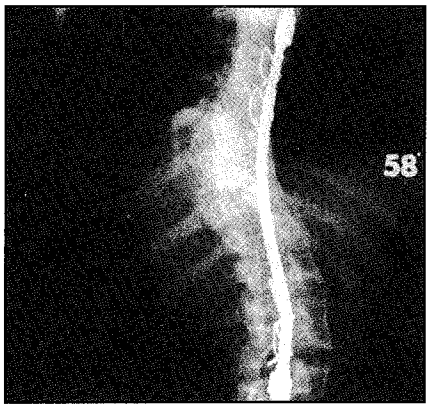

Figure 3A. Post operative A-P radiograph showing the coronal curve corrected to 58 degrees.

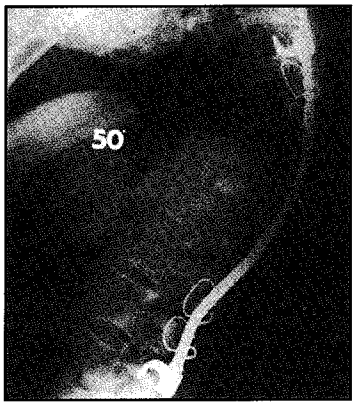

Figure 3B. Post operative lateral radiograph showing sagittal curve corrected to 50 degrees.

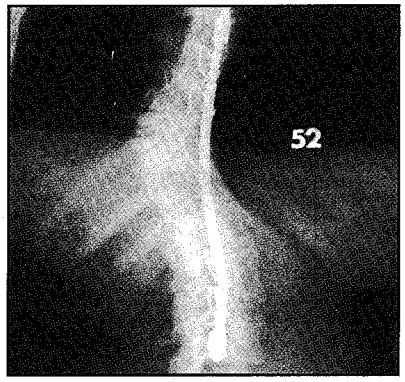

Figure 4A. A-P radiograph at maturity at 17 years and 10 months showing further correction of coronal curve to 52 degrees.

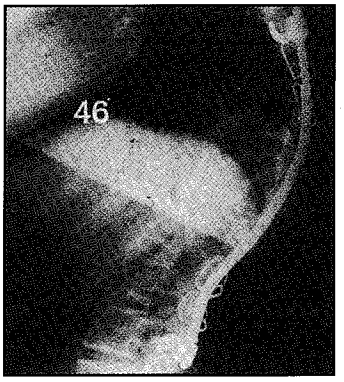

Figure 4B. Lateral radiograph at maturity showing the sagittal curve further correcting to 46 degrees. This is due to continued anterior spinal growth in the presence of a solid posterior fusion.

assumed when there was less than 10 degree loss at time of review.

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

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

to determine the factors which were significantly associated with an unstable arthrodesis. Data were analysed using chi squared test with $p < 0.05$ set as level of significance.

Results

Sixty-five patients underwent spinal arthrodesis. They were followed up for a mean of 6 years and 6 months, all patients having at least 2 years follow up. Fifty-seven patients reached skeletal maturity. Twenty-seven patients (42%) were deemed to have an unstable arthrodesis and 38 patients (58%) had a stable arthrodesis

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 ($p = 0.574$).

Table II
The effect of age at arthrodesis. Number of patients in relation to stability

Age at procedure	Stable	Unstable	Total	Odds ratio for instability
Less than 5 years age	9	2	11	0.182
Over 5 years age	35	19	54	0.352
Total	44	21	65	

X2 = 0.316 df = 1, p = 0.574

Table III
The effect of type of arthrodesis procedure
Number of patients in relation to stability

Procedure	Stable	Unstable	Total	Odds ratio for instability
Post arthrodesis <5 years	9	2	11	0.182
Post arthrodesis >5 years	13	13	26	0.500
Post arthrodesis + instrumentation	7	5	12	0.417
Ant + Post arthrodesis alone	7	0	7	0.000
Ant + Post arthrodiesis + instrumentation	8	1	9	0.111
Total	**44**	**21**	**65**	

X2 = 10.781, df = 4, p = 0.029

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 [1,7]. 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 [5].

Table IV
The effect of vertebral anomaly undergoing arthrodesis
Number of patients in relation to stability

Vertebral Type	Stable	Unstable	Total	Odds ratio for instability
Type 1	33	14	47	0.297
Type 2	8	0	8	0.000
Type 3	3	6	9	0.666
Unclassified	0	1	1	1.000
Total	44	21	65	

X2 = 11.5827, df = 5, p=0.041

Table V
The effect of curve size at arthrodesis. Number of patients in relation to stability

Curve size	Stable	Unstable	Total	Odds ratio for instability
< 40 degrees	8	2	10	0.200
40 to 80 degrees	16	12	28	0.429
> 80 degrees	20	7	27	0.259
Total	44	21	65	

X2 = 1.615, df = 2, p = 0.446

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 [2]. 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 [10]. 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 [11,12]. 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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