BENIGN INFANTILE IDIOPATHIC SCOLIOSIS
FACTORS OF POOR RESULTS AFTER CONSERVATIVE TREATMENT

Joseph W. WEHBE*, Ghassan N. MAALOUF*, Rita Maria A. CHIDIAC*
Alexandre H. NEHME*, Christian C. MORIN**

SUMMARY

Study Design: A retrospective study of 33 patients with infantile idiopathic scoliosis treated conservatively and evaluated at maturity is presented. Objectives: To determine the factors of poor results after conservative treatment in this type of scoliosis. Summary of background data: Some benign infantile idiopathic scoliosis can heal after conservative treatment while others are refractory to the same treatment. Methods: With the same conservative treatment 19 curves had positive results while 14 others needed surgical correction and fusion. A comparison between the two groups leads to the following conclusions: 1. Recovery is not exclusive to newborn scoliosis. It must be sought in progressive scoliosis, at least for the most flexible ones, called progressive. 2. The curves' reducibility during a first evaluation seems to be an important element of prognosis, as are the thoracic gibbosity, the Cobb angle and the presence of structural vertebral deformities. 3. Repeated bracing is the major element of conservative treatment. Its goal is to obtain a complete vertebral detorsion and a symmetrical thorax, crucial to a favorable long-term development. 4. The conservative treatment can be stopped well before maturity, provided the structural vertebral deformities have disappeared.

Key Words: *Idiopathic infantile scoliosis, Conservative treatment, Prognostic factors.*

INTRODUCTION

The infantile idiopathic scoliosis has a variable course. Some spontaneously resolve, and need only simple observation. While others are evolutionary and usually occur in growth-retarded children for whom surgical treatment becomes inevitable at the end of final growth[21-23]. Another less progressive scoliosis occurring in children with normal growth responds favorably to a well-conducted conservative treatment[26]. However, there are some exceptions to this rule. In this study, we will try to analyze the possible causes of negative outcomes in the latter type of scoliosis.

MATERIAL AND METHOD

26 patients in good physical shape with idiopathic scoliosis were screened for the present study. The factors considered are: age of detection, sex, type of curves, side, top, and frontal asymmetry, thoracic gibbosity, Cobb angle (44), vertebral rotation according to PERDRIOLLE (50), MEHTA angle, presence of structural deformities (deformity in the body of vertebrae), reducibility, conservative treatment with its duration and number of braces.

Patients' Recruitment

33 curves, considered as infantile idiopathic progressive, were treated conservatively at the Calot Institute of Berck for 26 patients, who were all examined at achievement of final growth. The age of detection was 21 months (6-44). 18 of these curves were simple thoracic ones, mainly left, with an apical vertebra located relatively low (T9-T10). There was one single lumbar vertebra, but 7 double majors, which raised the number of treated curves to 33. The imbalance in the frontal plane was frequent, and the gibbosity varied between 5 and 60 mm. Before treatment, the Cobb angle was between 24° and 86°. Besides the lumbar elements of 3 double curves, which measured between 24° and 32°, they were all above 40°. The apical vertebral rotation, measured with Perdriolle's torsometer, ranged between 5° and 45°. The Mehta costovertebral angle, measured at the top of the curve, was always positive before treatment and varied between 1° and 75°. Structural deformities of vertebral bodies were encountered 26 times out of 33usually at the apex.

* Asst. Prof., Orthopedics department, Saint George University Hospital, Beirut.
** Chief Children's Orthopedics Department, Calot Institute, Berck sur mer, France.

On the frontal X-ray under traction, the degree of improvement in Cobb angle varied between 25% to75%. The improvement of the vertebral rotation and the costovertebral angle was less important, not exceeding 50%.

Conservative Treatment

Serial braces to align the spine have always been a crucial part of the treatment. With the first brace, the trunc imbalance was first corrected. Then, the curve's angle, the vertebral rotation, the thoracic asymmetry were gradually corrected explaining the need for repeated bracing. The number of braces which were changed every 2 to 3 months was 5 on average per child. The last brace was determined after almost total correction of the vertebral rotation and of the thoracic asymmetry. It is kept for a longer period of time, between 6 and 18 months. This treatment with plastered corsets was started in very young children (the youngest was 9 months old). In the brace, the residual angle was 17 degrees (-4 to 40), the vertebral rotation and the Mehta angle often cancelling each other out.

It is then in the brace that the residual curves and gibbosities were improved. The structural vertebral deformities gradually disappeared. The conservative treatment ended ideally when the following elements were achieved: residual angle of the curve tending towards 0 degrees, vertebral rotation eliminated, good thoracic symmetry, and near-normalization of the apical vertebrae.

In 15 out of the 26 children, treatment was stopped before final growth.

Statistical Analysis

Analysis was done concerning 33 infantile scoliotic curves. The following variables were used in order to identify whether they affected final outcome: The age of detection, sex, left thoracic curve, asymmetry, gibbosity, cobb angle, vertebral rotation, Min Mehta angle, structural deformity, reducibility under traction before treatment in plastered brace and when the treatment was stopped. The Chi square and Yate correction (when indicated) were used for evaluation of qualitative variables such as sex, side, asymmetry, and structural deformity. The mean, median, variance and standard deviation were calculated and the difference between two group means was evaluated for quantitative variables: age of detection, cobb angle, rotation, Min Mehta angle, reducibility before, during and after treatment[37].

Results at Final Growth

All the patients were reexamined when their spinal growth was over. At the last assessment, after ending all conservative treatment the average Cobb angle was 14 degrees (0-55 degrees), the apical rotation was 10 degrees (0-55 degrees) and the costovertebral angle was 8 degrees (-20-55 degrees).

After a detailed analysis of the results 11 curves out of 33 (group I) can be considered as resolved. The residual angle is less or equal to 10 degrees, the apical rotation less than 5 degrees, and the costovertebral angle null or even negative. The clinical exam is normal (no asymmetry, no gibbosity, and a well-developed thorax). A significant angle remains in 8 other curves (group II) (10 < Cobb angle < 25 degrees). If a vertebral arthrodesis was not considered for these minimal residual flaws, we cannot say that there has been total recovery. Finally, during this period where 19 infantile curves did not undergo arthrodesis, 14 others had a less favorable evolution, which necessitated surgical intervention at the end of the growth period for 10 (Cobb angle>40 degrees) and for the four others (25<Cobb angle<40), close observation till adulthood (group III).

We can conclude with a number of prognostic factors concerning the conservative treatment by comparing between the infantile idiopathic curves that developed positively- sometimes towards full recovery- and those that were less positive (sometimes with an arthrodesis at maturity) (Tables I, II and III).

The Cobb angle was 44.6° in groups (I and II) versus 56.2° in group III with statistically significant difference $p<0.01$. A Cobb angle of 50° seems to have a predictable value: 85% of curves in group I + II are <50° and 75% of curves in group III are >50°.

The gibbosity was statistically smaller in group I + II than in group III (13 versus 28 mms). 16 mms can be considered as a critical angle. 90% of patients in group I + II had a gibbosity <16 and 81% > 16 in group III.

The structural deformity was present in all curves of group III before and at the end of treatment. In group (I + II), it was present in 12 curves out of 19 and in 4 curves only at the end of treatment.

The reducibility of curve (Cobb angle, vertebral rotation, Min Mehta angle) was 61%, 33% and 35% in group (I + II) versus 41%, 15%, and 24% in group III ($p<0.05$). 90% of the curves in group I+II were reducible at >55% of Cobb

Table I

	Positive Evolution (Group I + II) Characteristics of Curves	Negative Evolution (Group III) Characteristics of Curves		Statistics
Age of detection	21 months (6-44)	Age of detection	18 months (6-333333030)	NSD
Sex	7 boys - 8 girls	Sex	7 boys- 4 girls 8 thoracic	NSD
Curve type	10 thoracic; 4 double curves; 1 lumbar T* 11 left; 4 right;	Curve type	3 double curves curves T* 7 left, 4right right	NSD
Side	L* 2 right, 2 left 2xT7,2xT8,4xT9 4XT10,2xT11xT12	Side	L* 1 right, 2left left 2xT7,1xT8,5xT9 1xT10,2xT11,	NSD
Apex	4xL2	Apex	2xL1,1xL2	NSD
Clinical aspect		Clinical aspect		
Asymmetry	10 out of 15	Asymmetry	9 out of 11	NSD
Gibbosity	13 mm (5-20 mm)	Gibbosity	28 mm (15-60 mm)	$p < 0.05$

T*: Thoracic; L*: Lumbar NSD: non significant difference.

Table II

Positive Evolution (Group I + II) X-ray Prior to Treatment		Negative Evolution (Group III) X-ray Prior to Treatment		Statistics
Cobb angle	44.6° (24° - 60°)	Cobb angle	56.2° (32° - 86°)	$p < 0.01$
Vertebral rotation	19.5° (5° - 30°)	Vertebral rotation	22° (5° - 45°)	NSD
Mehta angle	29.2° (1° - 41°)	Mehta angle	32° (10° - 75°)	NSD
Structural deformity	12 / 19	Structural deformity	14 / 14	$p < 0.01$
X-ray under traction		**X-ray under traction**		
ReducibilityCobb angle	61%	Reducibility Cobb angle	41%	$p < 0.01$
Reducibility vertebral rotation	33%	Reducibility vertebral rotation	15%	$p < 0.01$
ReducibilityMehta angle	35%	Reducibility Mehta angle	24%	$p < 0.05$

Table III

Positive Development (Group I + II) Plastered Braces		Positive Development (Group III) Plastered Braces		Statistics
Age 1st brace	2 years, 10 months (9 m 6 yrs 6)	Age 1st brace	4 years (9 m 7 yrs 9)	NSD
Cobb angle	15.5° (-4° - 28°)	Cobb angle	19.5° (2° - 40°)	NSD
Vertebral rotation	4° (0° - 10°)	Vertebral rotation	15° (4°- 42°)	$p<0.05$
Mehta angle	9° (-10° - 35°)	Mehta angle	19° (2° - 50°)	$p<0.05$
Number	5	Number	8	$p<0.05$
Time in brace	18 months	Time in brace	35 mths	$p<0.05$
Treatment stopped		**Treatment stopped**		
Age	8 yrs, 8 mths (4 yrs-12 yrs, 8 mths)	Age	12 yrs, 8 mths (5 yrs, 7 mths-16 yrs, 8 mths)	$p<0.01$
Cobb angle	6° (0° - 20°)	Cobb angle	40° (10° - 55°)	$p<0.01$
Vertebral rotation	3° (0° - 15°)	Vertebral rotation	18° (5° - 55°)	$p<0.01$
Mehta angle	-7° (-20° - 3°)	Mehta angle	23° (4° - 55°)	$p<0.01$
Structural deformity	2 / 10	Structural deformity	10 / 10	$p<0.01$

angle, 30% of vertebral rotation, and 30% of Min Mehta angle. In group III, 82% of curves were reducible at <55%, <30%, <30%.

6 curves in group I with Cobb angle <50°, in which structural deformity was absent, gibbosity <15 mms, and reducibility < 55%, 30%, 30%, healed completely.

4 curves in group III had a Cobb angle <50° but the reducibility rate was < 55%, 30%, 30% with presence of structural deformity and gibbosity >16 mms. The effect of these factors are statistically cumulative: Cobb angle (50°) +reducibility (55%, 30%, 30%): $p < 0.05$. Cobb angle+ reducibility+ structural deformity + gibbosity (16 mms): $p < 0.01$.

RESULTS

The infantile idiopathic scoliosis is detected before 3 years[15,32], and has no known causes. It appears on spines that have a very important growth potential[5,17]. Its developmental evolution can be worrying[6,7,14].

One of the most surprising characteristics of scoliosis starting in early childhood is the possibility for some to spontaneously recover, and for others to considerably worsen. It is currently the habit to use the term infantile idiopathic scoliosis for the progressive forms exclusively; the forms spontaneously resolving being studied separately under the term neonatal scoliosis[9]. The vast majority (90%) of early childhood scoliosis belongs to this group of scoliosis spontaneously recovering. In the beginning, there is no certainty allowing us to make the distinction between those that will recover and those that will get worse[15].

It is crucial to know very early on which direction will take a scoliosis detected in the first months of life. The results of clinical observation are insufficient to give a prognosis at an early stage. The Cobb angle is not an absolute criterion of distinction, even if most resolving curves measure less than 40 degrees in the beginning[28]. On the other hand, the study of costovertebral rotation appears to be the best element in this respect. It was to the great credit of Min Mehta[21] to have shown the relation with the resolving type of scoliosis: the measure of the difference between the costovertebral angle concave and convex. In 80% of the recovering scoliosis, the difference is less than 20°. It is higher than 20° in the 20% remaining, but in these latter cases, the difference is limited to the three following months, even if the Cobb angle tends to increase. In 80% of the progressive angles, the difference is equal or higher than 20. When it is less than 20°, this difference will be identical or higher three months later.

The frontal radiological examination is of importance for visualization of some prognostic elements, such as cuneiform deformities of the apical vertebrae[24] and the low reducibility of curves, especially of the apical zone on the dynamic X-rays. An analysis of a lateral X-ray will sometimes show a slump of the spine in kyphosis by extreme rotation of the vertebral bodies at the top of the curve[5,12,13].

In almost two thirds of the cases, it was possible to avoid the vertebral arthrodesis at the end of growth, and in one case out of three, the scoliosis was able to heal. The conditions for success of such a treatment are differently appreciated. The age of detection which is usually a major prognostic factor has not been found to be of importance in the present study[2,4,14,15]. More importantly seems to be the age of the beginning of treatment, with an age limit of 6 years being suggested by Fauchet[10]. The ill reputation of the left thoracic[1,11] and of the feminine sex[35] is not observed either. However, the gibbosity seems to have a certain prognostic effect proven also by other authors[8]. In our study, a gibbosity of 16 mms had a predictable value. Also, the initial Cobb angle is higher in curves that might evolve negatively, and a number of scientists have already made this observation[8,17,32,35]. The apical vertebral rotation at first worrisome[30,35] has been found to have no impact on our results. This is equally true for the thoracic asymmetry and the Mehta angle at initial evaluation. The best indicators of a bad prognosis on the standard frontal X-ray were the presence of structural deformities of the vertebrae[26]. The inversion of the thoracic kyphosis negative for some[20] was not studied. The reducibility under traction (Cobb angle, apical rotation, Mehta angle) seems to be significantly better with the curves that will evolve positively. A treatment of plastered braces, obtaining a near-complete alignment of the scoliotic curve and bringing about a symmetric thorax is the best guarantee for a favorable final outcome[14,23,25,33]. A slightly delayed beginning of the treatment and the persistence of a residual frontal angulation are not necessarily elements of bad prognosis in our study. However, not everyone agrees with this[10,36].

The higher number of plastered braces and consequently the longer the time spent in a plaster demonstrate the greater difficulty in obtaining a good alignment in case of unfavorable evolution. It is not the prolongation of the conservative treatment that would guarantee a better result. It has been stopped before the age of 9 years in patients having evolved favorably, whereas in cases of negative evolution, the treatment was stopped 4 years later. It is however important to strictly respect the criteria for stopping the conservative treatment[23,26]. Only curves having at the end of treatment a Cobb angle less than 20°, a vertebral rotation less than 10°, a Mehta angle null or negative and without structural deformity have evolved towards healing.

DISCUSSION

In the infantile idiopathic scoliosis the conservative treatment is a crucial element. In the severe forms, it can carry the child through to the age of surgery in better conditions[14,19]. It consists of plastered braces in a first stage, followed by orthopedic braces, particularly the Milwaukee brace[16,25,27,31]. But we can sometimes be brought to intervene early on, in order to use a distracting rod sometimes associated with an anterior or posterior arthrodesis in convexity[14,19,21,29].

In the intermediate progressive forms, conservative treatment can result in total recovery of the scoliosis. This treatment must be started at an early stage and must be rigorous. It can also start with adjusted plastered braces, renewed with patience until a near-complete alignment with symmetry of the thorax is achieved, and then the rest is gradually carried out through orthopedic braces until the disappearance of vertebral deformities. These objectives are not always attained, and the arthrodesis is necessary at maturity. In these cases, the risk factors are: reducibility, thoracic gibbosity, the Cobb angle and structural deformities. When several risk factors exist, it would be useful to associate a minimal surgical intervention, such as a rib resection[35] or a costodesis associated with a contralateral release[34]. This second intervention seems to give positive results if the Mehta angle is lower than 30°.

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