The Effect of an Exercise Program on Change in Curve in Adolescents with Minimal Idiopathic Scoliosis

A Preliminary Study

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Forty-two adolescents with minimal idiopathic scoliosis, who had been on an exercise program for 9 to 15 months, were evaluated to determine the influence of exercise on change in their curvatures. A difference of 4 degrees or greater between initial and final curve measurements was considered to be a change. Five percent of the curves increased, 74 percent remained the same, and 21 percent decreased. Change in curvature for these patients was also compared with that of a matched retrospective group of adolescents with scoliosis who had not had the exercise program. No significant difference in change in curve between the two groups was found. For patients who had been on the exercise program, there was no significant relationship between change in curve and extent of physical activity or between change in curve and exercise recall, correct performance, or frequency. Limitations in the study design and possible explanations for the results are discussed.

Key Words: *Exercise therapy, Physical therapy, Posture, Scoliosis.*

Studies of the effect of exercise on idiopathic scoliosis are lacking in the English-language literature. Exercise alone is not currently used in managing scoliosis because clinical experience has historically demonstrated progression of curves despite vigorous exercise regimens. Rather, exercise is thought to be beneficial when performed by patients wearing trunk orthoses such as the Milwaukee or Boston braces. Pilot studies (unpublished data from Braithwaite, 1973, and Miyasaki, 1974) have supported the beneficial effects of two exercises when performed in the Milwaukee brace.

Knowledge about the response of idiopathic scoliosis to exercise alone has been gained from experience with moderate to severe curves, that is, those of approximately 20 degrees or greater. With the advent of school screening programs, minimal curves (those less than 20 degrees) are being detected, thus affording the opportunity to investigate the effect of exercise on the small, unbraced curve.

In 1971, Rancho Los Amigos Hospital (RLAH) instituted a community-centered scoliosis screening program for seventh- and eight-grade students. Data for a prospective study of the epidemiology and clinical course of lateral curvatures of the spine in adolescents were collected.[1, 2] The majority of curves were minimal idiopathic scoliosis curves (MISC) of 5 to 20 degrees. The program consisted of observational de-

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tection of the curve and use of roentgenograms to verify the curvature and to monitor its progression. For the first two years, a therapeutic intervention program was provided only for adolescents whose curves warranted use of a Milwaukee brace (generally, those curves greater than 20 degrees).

After this two-year period, exercises were incorporated into the follow-up protocol in response to a request from Dr. Brooks, director of the screening program. A simple exercise program was developed and provided for all patients with MISC seen for the first time in the screening clinic between December 1973 and December 1974. This report summarizes the methods and results of this program.

METHOD

Subjects for the study were members of the seventh- and eighth-grade classes of Los Angeles County public schools who were 12 to 15 years old when the study began. All subjects had positive clinical findings on the screening examination and roentgenographic evidence of lateral curvature of the spine of 5 to 20 degrees.

The subjects were divided into two groups: an exercise group consisting of 42 subjects and a control group consisting of 57 subjects who were not instructed in an exercise program. Control subjects were retrospectively drawn from adolescents referred to the clinic during the two years before this study began. Control and exercise patients were matched by: 1) sex, 2) months of follow-up (±3 months), 3) initial level of curve (±2 vertebral levels), and 4) initial degrees of curve (± 4 degrees). These degrees represent the mean absolute difference in roentgenogram measurements by two physicians, as determined from 10 roentgenograms.[3] The Cobb method was used to determine degrees of curvature.[4]

One hundred sixty-eight adolescents were taught the exercise program by a physical therapist at their initial clinic visit. The purpose of the exercises was to mobilize and strengthen the trunk and to improve upright posture. The following exercises were selected from the program taught to RLAH patients in a Milwaukee brace.[5]

Supine:

1. Pelvic tilt with flexed knees.
2. Single leg lift with flexed knees and pelvic tilt.
3. Partial sit-up with flexed knees, arms across the chest, and pelvic tilt.

Sitting:

4. Lateral trunk bend to the convex side of the curve. For double curves, bending was either to one or both sides, as determined by the severity of each curve.

Standing:

5. Pelvic tilt against the wall.

Subjects were given an illustrated copy of the exercise program and a log on which to record the frequency of their exercise performance. They were instructed to perform the exercises once daily, 10 times each.

At subsequent clinic visits, new roentgenograms were taken and exercise performance was checked. The physical therapist observed the exercises and either reinstructed the patient or instructed him to progress in the program. If performance was satisfactory, the number of repetitions was increased or more difficult exercises were added. Exercises of greater difficulty consisted of: 1) pelvic tilt with knees straight, 2) double leg lift while holding the pelvic tilt, 3) partial sit-up with hands behind the head, holding the pelvic tilt, 4) pelvic tilt, standing away from the wall, and 5) walking with the pelvis tilted and with good posture.

At initiation of the screening program, all patients were scheduled for return clinic visits every three months. As the physicians' experience with MISC increased, clinic visits were scheduled as follows: patients with a thoracolumbar curve of less than 10 degrees returned every six months; those with a thoracic curve or a thoracolumbar curve greater than 10 degrees were scheduled every three to four months.

A 12-month study period was chosen for the exercise group because one year was the average length of time that the adolescents in the retrospective control group had been followed. Testing occurred between 9 months and 15 months, with most patients being tested at the 12th-month clinic visit or the regular visit closest to that time. Testing as early as 9 months or as late as 15 months was allowed so that patients who did not return to clinic at 12 months could be included in the study.

The patient's ability to recall and to perform the instructed exercises was assessed by one of two physical therapists. Subjects were asked to demonstrate all the exercises in their current program. If a patient did not remember an exercise, the therapist reminded him what the exercise was and asked him to perform it.

The adolescents also completed two checklists. On one, they indicated the number of times per week or month, during each season of the year, that they had participated in the listed sports, hobbies, and recreational activities. On the other, they reported how often they exercised per week during each quarter of the year. Parents also reported their child's frequency of exercising by completing a separate checklist.

Interrater reliability was calculated for the two physical therapist testers and for the physicians who

TABLE 1

Change in Curve of Patients with Minimal Idiopathic Scoliosis Curves Participating in an Exercise Program (n = 42)

Change in Curve[a]	Patients Showing Change	
	Number	%
Increased	2	5
Same	31	74
Decreased	9	21
TOTAL	42	100

[a] Increase or decrease of ≥4 degrees.

measured the roentgenograms. Both therapists were present for the first 10 follow-up assessment visits and recorded their observations on separate data sheets. Each therapist was the tester for five subjects while the other observed. Agreement between the physical therapists was 95 percent for recall and 78 percent for performance. The physicians each measured 10 roentgenograms of patients not on the study.[3] The mean absolute difference in measurements was 4.2 degrees ±0.95 (SEM).

RESULTS

Follow-up data were gathered on 42 patients who remained on the exercise program for the specified follow-up period. Of these patients, 13 (31%) were boys and 29 (69%) were girls. There were 14 right curves, 21 left curves, and 7 double curves. Curves at the initial visit ranged from 4 degrees to 22 degrees, with a median of 10 degrees. At the assessment visit, curves ranged from 0 to 20 degrees with a median of 8.5 degrees.

Change in Curve for the Exercise Group

Degrees of curvature were compared from initial to follow-up visits. Changes greater than 4 degrees were considered to be an increase or decrease in the curve. The distribution of patients by change in curve is shown in Table 1. Two curves increased, 31 remained the same, and 9 decreased. All double curves remained the same. The average decrease was 8.2 degrees; the average increase was 6.5 degrees.

Comparison of Change in Curve for Exercise and Control Group Patients

Computer-stored measurements of curvature were retrieved on the 57 control patients who had been followed for 9 to 15 months. From these 57 control patients and the 42 exercise patients, 31 matched pairs were drawn. A paired t test indicated no difference in change of curve for the exercise and control patients (t=0.16, df=30, NS).

Relation of Change in Curve to Activity, Performance, and Frequency of Exercise

Patients were grouped by change in curvature and high and low scores for activity, performance, and frequency of exercise. Data were analyzed by chi-square analyses. Yates' correction for continuity was used (Tab. 2). No difference was found in the change of curvature 1) between patients who had been physically active and those who had not (χ^2=0.03, df=1, NS), 2) between patients who exercised an average of at least four to six times per week and those who did not (χ^2=0.11, df=1, NS), or 3) between patients who performed at least 75 percent of the exercises correctly and those who did not (χ^2=0.35, df=1, NS).

TABLE 2

Relationship of Change in Curve to Activity, Performance, and Frequency of Exercise

Change in Curve	Number of Patients According to Change in Curve					
	Activity Level[a] (n = 40)		Performance[b] (% Correct) (n = 42)		Frequency of Exercising[c] (Average) (n = 41)	
	Inactive	Active	0–74%	75–100%	Never or 1–3 times/wk	4–6 times/wk or daily
Increased	1	3	1	1	1	1
Same	8	19	15	16	14	16
Decreased	3	6	6	3	4	5
TOTAL	12	28	22	20	19	22
	$\chi^2 = 0.03^d$		$\chi^2 = 0.35^d$		$\chi^2 = 0.11^d$	

[a] Based on checklist entitled "Participation in Sports, Hobbies, and Recreational Activities."
[b] Performance of instructed exercise at follow-up assessment.
[c] Based on checklist for frequency of exercising.
[d] For chi-square with 1 df, "increased" and "same" categories in change in curve column were collapsed. Results were not significant ($p > .05$).

TABLE 3
Distribution of Scores for Recall and Performance of Exercises (n = 42)

Score (% Correct)	Patients for Each Score			
	Recall		Performance	
	Number	%	Number	%
100	19	45	11	26
75–99	6	14	9	21
26–74	14	33	12	29
0–25	3	7	10	24
TOTAL	42	100[a]	42	100

[a] Percentage does not equal 100 because of rounding off.

Recall and Performance of Exercises

Percentages of correct responses for both recall and performance of exercises were calculated for each patient. The distribution of scores is found in Table 3. Approximately half of the patients (19) remembered all their exercises; another six remembered all but one exercise. Only one patient could not recall any exercises. In testing performance, 11 patients did all exercises correctly and 9 patients did at least three-quarters of the exercises correctly. Ten patients correctly performed only one quarter or less of the exercises.

Frequency of Exercise

Frequency of exercise was categorized and each category was assigned a number. Responses were added and an average level of exercising calculated for the year. As shown in Table 4, of 41 adolescents who completed the form, only four exercised at home daily or almost daily. Eighteen exercised an average of four to six times per week, 10 exercised an average of one to three times per week, and 9 never or almost never exercised.

Thirty-seven parents separately assessed their children's exercise frequency. Ninety percent of the reports by parent and child were the same or similar; only three parents (8%) overstated their child's participation in at-home exercises.

TABLE 4
Distribution of Scores for Average Frequency of Exercising (n = 41)

Score (Average Frequency of Exercising)	Patients for Each Score	
	Number	%
Never or almost never	9	22
1–3 times per week	10	24
4–6 times per week	18	44
Daily or almost daily	4	10
TOTAL	41	100

Relationship of Recall, Performance, and Frequency of Exercise

Chi-square analyses indicated there was no relationship between performance scores and frequency of exercise (χ^2=3.02, df=1, p>.05) or between the frequency of exercising and recall at the time of testing (χ^2=2.89, df=1, p>.05). However, the relationship between recall and performance of exercises was significant (χ^2=5.62, df=1, p<.025). Patients who recalled all or most of their exercises tended to perform them well, while those who could not recall them were not able to do them correctly.

Participation in Sports, Hobbies, and Recreational Activities for the Exercise Group

Data obtained from the "Participation in Sports, Hobbies, and Recreational Activities" questionnaire were used to classify subjects as either physically active or physically inactive. Subjects were considered to be physically active if they engaged in at least one strenuous activity (such as basketball, tennis, bicycling, gymnastics) daily or almost daily throughout the 12-month period of the exercise program. Subjects who did not meet the physically active criteria were considered to be physically inactive. Activities done in school physical education classes were not included. Twelve subjects were inactive; 28 were active. Two persons did not complete the form.

DISCUSSION

Changes in scoliotic curves between exercise and control groups were not significant. In addition, the number of exercise group patients showing change in curvature was essentially the same as that found by Brooks and associates.[2] These researchers did a prospective study of 134 patients who had not been on the exercise program; the control group for this study was drawn from these patients. In the current study, 21 percent of the patients had curves that improved, 5 percent had curves that deteriorated, and 74 percent had curves that did not change. Brooks and associates found that 22 percent improved, 5 percent deteriorated, and 73 percent remained unchanged.[2]

One explanation for this result is that the patients were not exercising, at least not according to instructions. Only about half of the patients exercised more days than not and only 59 percent could remember all or most of the exercises taught to them. Only 48 percent of the group could perform all or most of the exercises correctly. Closer supervision and follow-up would have been needed to assure the desired frequency of exercise and to assure that correct performance was learned and practiced. Although correct performance of the exercises at the desired frequency might not have altered the results, such compliance would have strengthened the finding that the exercises had no effect on MISC. The anticipated relationship between frequency of exercise and correctness in performance was not seen and could have resulted from inadequate learning and incorrect practice of the exercises.

Change in curvature was not related to level of physical activity, frequency of exercising at home, or ability to perform instructed exercises. However, the effects of some aspect of physical activity on the scoliotic curves may have been obscured by inaccuracies and inconsistencies in reporting. It is not surprising that no relationship was seen between change in curve and scores of performance or frequency of exercising, inasmuch as change in curve was identical for exercise and control groups.

CONCLUSION

Based on this study, we cannot conclude that exercise has no effect on change in curvature in patients with minimal idiopathic scoliosis. We can unequivocally say, however, that this specific exercise regimen and method of instruction and follow-up had no effect on change in curvature in this group of patients.

The screening program is continuing in schools in this geographical area. Because additional patients are becoming available to us, we hope to be able to continue our study of the effect of exercise on the minimal idiopathic curvature. A possible future study would be prospective and include the following: 1) exercise for only a select group of patients, with others serving as controls, 2) development of an expanded exercise program, possibly to include such exercises as strengthening of trunk extensor muscles, lateral trunk shifting several times a day,[6] and stretching of tight hip flexor and hamstring muscles, 3) performance of the program twice instead of once daily, 4) establishment of outpatient physical therapy visits for exercise follow-up, 5) use of school physical education teachers, trained by us, for five-day-a-week supervision of the exercise program, and 6) extension of the follow-up period to 24 or 36 months. Such a study might provide more conclusive evidence that exercise does or does not effect a change in the minimal idiopathic scoliosis curve.

Even if future studies show that exercise has no influence on progression of minimal scoliosis, there may be other positive results of a closely supervised exercise program that could justify its inclusion as part of the follow-up plan. For example, if the exercise program fostered the patient's interest in his condition and facilitated his continued return to the physician for roentgenograms, it would have made an important contribution to the total management of the adolescent whose curve will increase.

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