

Pain and Radiographic Outcomes in Adult Idiopathic Scoliosis Patients Using a Scoliosis Activity Suit: An 18-Month Case Controlled Chart Review

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Abstract

There are few conservative treatment options for patients with adult idiopathic scoliosis. These typically include pharmacologic pain management, epidural injections, and generalized CAM treatments such as massage and chiropractic manipulation. The purpose of this study was to compare the post-treatment results in patients wearing the scoliosis activity suit versus baseline assessments as well as adult scoliosis patients who did not wear the activity suit. The pain and Cobb angle outcomes of 53 consecutive patients with adult idiopathic scoliosis following a trial of a scoliosis activity suit were reviewed. The average scores and measurements at 18 months were statistically significantly improved for both the quadruple numerical pain rating scale as well as Cobb angle. The scoliosis activity suit may be a viable supportive therapy for the treatment of chronic pain associated with adult idiopathic scoliosis. Further prospective studies should evaluate treatment effects of this suit using intent-to-treat methodology.

Keywords

Scoliosis, Pain, Spine, Rehabilitation

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1. Introduction

The treatment options for idiopathic scoliosis have greatly developed over the last decade. Bracing techniques [1] and surgical techniques [2] have consistently been made available to adolescent idiopathic scoliosis patients. However, many of the non-surgical procedures have not been available to adult idiopathic scoliosis patients. It is well known that idiopathic scoliosis can continue to progress even into adulthood [3]. When an idiopathic scoliosis measures $>30^\circ$ at the time of skeletal maturity, there is approximately a 68% chance that the curve will continue to progress thereafter [4] [5]. For example, a study by Marty-Poumarat *et al.* [6], reported a near linear rate of progression year by year into later adulthood.

Most of the treatment studies in adults with idiopathic scoliosis have been surgical. However, common among the various surgical techniques is the incidence of perioperative and postoperative complications, ranging from 17% - 55% [7]-[9]. The chance of revision surgery in a study of 306 patients was 44% in the first 6 years [10]. Since rigid scoliosis bracing is typically indicated for skeletally immature patients, rigid bracing in adulthood is not considered necessary [11]. According to the Society on Scoliosis Orthopedic and Rehabilitation Treatment (SOSORT), bracing for adult curves is indicated only when the therapeutic value of the brace chosen has been established [12]. However, many of the brace technologies established for adult scoliosis patients are European, and their availability in the US is limited at the present time.

With the potential risks of surgical intervention in adulthood, and the limited availability of European bracing technologies in the United States, we report the results of a scoliosis activity suit used in a cohort of patients with adult idiopathic scoliosis.

Previous early data suggest [13] that this suit may help certain pain and radiographic parameters of scoliosis. Here we present our data against a previously published control group with established progression data in adult scoliosis cases.

The scoliosis activity suit is a neoprene, rotation-based activity suit, composed of 4 distinct pieces. The novelty of the scoliosis activity suit is that it creates a rotational resistance into the torso that accentuates the rotational displacement of the scoliosis. This increased rotational stimulus is thought to elicit a corrective postural reflex that results in de-rotation of the spine out of the scoliosis curvature.

2. Intervention and Outcomes

Patient files from a single multidisciplinary medical center were consecutively pulled for analysis. All patients had previously reported to this clinic with an established history of adult idiopathic scoliosis. Inclusion criteria for this study included 1) Prior to treatment intervention, all patients completed a quadruple numerical pain rating scale, 2) patients were all skeletally mature at baseline, 3) baseline Cobb angle of at least 30° , and 4) they were not receiving concurrent treatment or being followed up with elsewhere. Patient files were excluded if the type of scoliosis was not idiopathic, as well as patients with history of scoliosis fusion surgery. A total of 53 patient files were consecutively selected, so as to minimize selection bias.

Patients had participated in a fitting process, where the focus was on teaching each patient to properly fit and adjust his/her scoliosis activity suit based upon his/her respective curve pattern. They were also given instruction on which specific activities of daily living to perform while wearing the activity suit. Patients were instructed to wear the activity suit for a total of 4 - 6 hours per day total, in two separate sessions (2 - 3 hours each ideally). **Figure 1** shows an illustration of a typical configuration for an adult patient.

Once the patients completed their fitting process, they were instructed to report back every 3 months for 1 year, followed by 6-month intervals thereafter. At each 6-month interval, patients again completed the numerical pain rating scale. These questionnaires were compared to baseline to determine their pain and changes.

The gender breakdown among the 53 total patients selected for this study was 41 females and 12 males. Of these 38 had curves above 30° while 15 had curves above 50° . When categorized based upon curve pattern, there were 8 patients with thoracolumbar curves, 19 with thoracic curves, 10 with lumbar curves, and 16 with double major curves.

Statistical analysis was performed for the curve pattern groups as well as the baseline Cobb angle groups. Student t-tests were performed to evaluate before and after treatment comparisons. **Tables 1-5** provide an outline of this data for the outcome assessments. Across the entire cohort, 79% of patients achieved a curve correction of 6° or greater, 17% had curves unchanged or stabilized (defined as $<6^\circ$ of change), and 4% saw their curves increase. When subdividing the entire cohort by curve pattern, the thoracolumbar group achieved the



Figure 1. A common sample configuration of the scoliosis activity suit.

Table 1. Entire cohort.

Patient	Gender	CurveType	Cobb1	Cobb2	QVAS1	QVAS2
1	f	L	55	50	63	43
2	m	D	32	22	47	37
3	f	L	36	26	60	53
4	m	T	52	33	43	33
5	f	TL	34	30	70	43
6	f	T	42	29	40	20
7	f	T	44	26	30	20
8	f	L	66	40	73	47
9	m	TL	47	30	53	43
10	f	D	33	20	33	30
11	f	TL	38	30	60	37
12	m	T	52	35	73	47
13	f	L	61	51	63	47
14	f	T	35	30	33	20
15	f	D	49	36	37	20
16	f	D	39	33	43	10
17	f	L	40	33	57	30
18	f	D	46	29	43	27
19	m	T	56	28	57	43
20	f	D	31	20	47	40
21	f	T	38	25	43	30
22	f	L	38	24	67	40

Continued

23	f	D	33	20	37	13	
24	m	D	32	26	43	27	
25	m	T	30	21	20	20	
26	f	D	38	27	33	17	
27	f	D	47	33	43	27	
28	f	T	41	35	37	30	
29	f	L	65	55	60	27	
30	f	T	40	18	33	17	
31	f	T	54	26	57	27	
32	m	TL	39	31	67	23	
33	f	T	34	34	43	40	
34	f	D	58	59	43	43	
35	f	T	37	29	47	40	
36	f	TL	39	20	77	63	
37	f	L	53	49	53	43	
38	f	T	44	40	53	47	
39	f	D	46	48	60	23	
40	f	T	61	56	73	33	
41	m	D	45	42	43	40	
42	f	L	43	39	50	40	
43	m	T	60	53	60	47	
44	f	TL	48	37	50	37	
45	f	T	32	30	37	30	
46	f	D	59	52	43	37	
47	f	L	39	31	57	33	
48	m	T	53	46	37	20	
49	f	TL	31	15	53	37	
50	f	D	30	26	47	30	
51	f	D	34	21	53	47	
52	f	TL	32	23	47	40	
53	m	T	62	50	67	27	
P value				1.36204E-06		1.03956E-10	
Mean				43.830189	33.43396226	50.150943	33.67924528
42		79%	>6°				
9		17%	<6°				
2		4%	Progressed				

Table 2. Lumbar curves.

Patient	Gender	CurveType	Cobb1	Cobb2	QVAS1	QVAS2
1	f	L	55	50	63	43
3	f	L	36	26	60	53
8	f	L	66	40	73	47
13	f	L	61	51	63	47
17	f	L	40	33	57	30
22	f	L	38	24	67	40
29	f	L	65	55	60	27
37	f	L	53	49	53	43
42	f	L	43	39	50	40
47	f	L	39	31	57	33
		P value		0.035705		6.80694E-06
		Mean	49.6	39.8	60.3	40.3
	7	70%				
	3	30%				
	0					

Table 3. Double curves.

Patient	Gender	CurveType	Cobb1	Cobb2	QVAS1	QVAS2
23	f	D	33	20	37	13
24	m	D	32	26	43	27
26	f	D	38	27	33	17
27	f	D	47	33	43	27
34	f	D	58	59	43	43
39	f	D	46	48	60	23
41	m	D	45	42	43	40
46	f	D	59	52	43	37
50	f	D	30	26	47	30
51	f	D	34	21	53	47
		P value		0.01719916		8.47507E-05
		Mean	40.75	32.125	43.4375	29.25
	12	75%				
	2	12.50%				
	2	12.50%				

Table 4. Thoracic curves.

Patient	Gender	CurveType	Cobb1	Cobb2	QVAS1	QVAS2
4	m	T	52	33	43	33
6	f	T	42	29	40	20
7	f	T	44	26	30	20
12	m	T	52	35	73	47
14	f	T	35	30	33	20
19	m	T	56	28	57	43
21	f	T	38	25	43	30
25	m	T	30	21	20	20
28	f	T	41	35	37	30
30	f	T	40	18	33	17
31	f	T	54	26	57	27
33	f	T	34	34	43	40
35	f	T	37	29	47	40
38	f	T	44	40	53	47
40	f	T	61	56	73	33
43	m	T	60	53	60	47
45	f	T	32	30	37	30
48	m	T	53	46	37	20
53	m	T	62	50	67	27
		P Value		0.00071025		0.0003936
		Mean	45.6315789	33.8947368	46.4736842	31.1052632
	16	84%				
	3	16%				

Table 5. Thoracolumbar curves.

Patient	Gender	CurveType	Cobb1	Cobb2	QVAS1	QVAS2
5	f	TL	34	30	70	43
9	m	TL	47	30	53	43
11	f	TL	38	30	60	37
32	m	TL	39	31	67	23
36	f	TL	39	20	77	63
44	f	TL	48	37	50	37
49	f	TL	31	15	53	37
52	f	TL	32	23	47	40
		P value		0.002114		0.00167
		Mean	38.5	27	59.625	40.375
	7	88%				
	1	12%				

largest correction, with 88% of thoracolumbar curves correcting $\geq 6^\circ$. The thoracic group achieved this in 84% of patients. By contrast, the lumbar group saw the lowest correction rate at 70%, followed by the double major group at 75%. However, the double major group is the only group in which patients saw their curves worsen at follow-up (12.5%). The curve progression in each patient was 1° and 2° respectively. This is approximately equal to the natural history of progression for these curves. **Figure 2** shows some of the postural changes triggered by application of the suit.

When comparing these curve patterns to the published control group by Marty-Poumarat *et al.* [6], the average initial age of their subjects was 37 years; ours was 44. The average starting Cobb angle for lumbar and thoracolumbar curves was 30° , while our lumbar group started at 50° and our thoracolumbar group was 39° . Thoracic curves began at 44° for the control subjects, and our thoracic group began with 46° curves. According to Marty-Poumarat *et al.*'s data [6], they observed average thoracic curve progression of 0.68° per year. This would equate to roughly 1.02° curve increase over our present 18-month study timeframe. Our thoracic group saw their curves improve, by contrast, of 12° ($P < 0.05$). Lumbar and thoracolumbar curves increased 1.45° per year in the control group, whereas our lumbar group saw an average curve correction of 10° ($P < 0.05$) and the thoracolumbar group corrected an average 11° ($P < 0.05$).

3. Discussion

Since most adult scoliosis patients seek therapy for their scoliosis due to pain [12], it is logical to evaluate those methods that seek to accomplish this goal, even if curve correction is unattainable.

Our control group was composed of a previously published cohort by Marty-Poumarat *et al.* [6]. Our present cohort is similar in demographics and curve characteristics to their cohort, which is why it was chosen. Since Marty-Poumarat *et al.* provided a detailed, linear rate of progression for adult scoliosis patients, it gave us a realistic comparative by which to evaluate if the scoliosis activity suit could potentially alter the course of natural history of this disease process.

It is important to discuss the limitations of this study. While we did attempt to control the study, it was retrospective in nature, which invariably provides for some degree of selection bias, although we attempted to minimize this by selecting our inclusion criteria before reviewing and selecting patient charts. We also did not perform an intent-to-treat analysis, which would have accounted for the subjects who did not report for follow-up at 18 months. Future studies should include this analysis.

Although this treatment was primarily performed at home, our present study does not take into account the percentage of compliance within our study population. It is possible that our outcomes could be correlated to the rate of compliance, as well as for those we lost to 18-month follow-up.

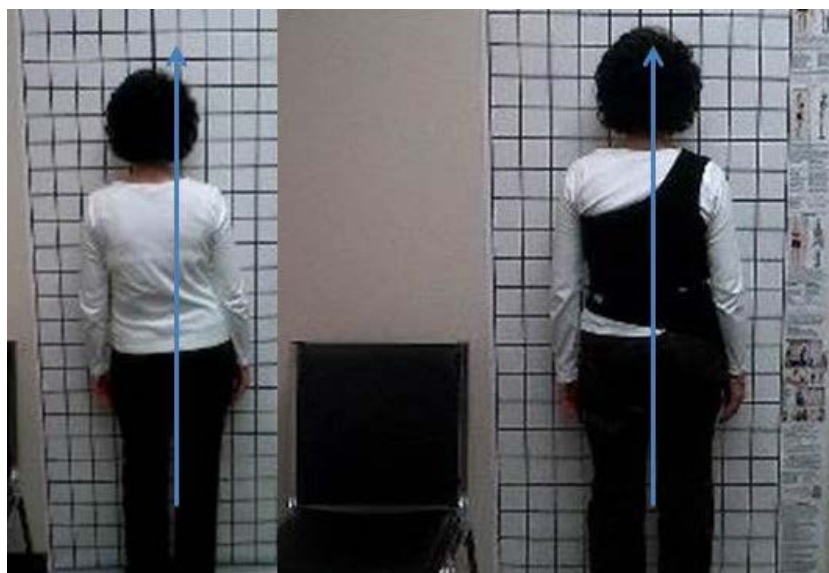


Figure 2. Postural changes associated with the scoliosis activity suit.

Finally, while pain is a reasonable outcome assessment for this patient population in particular, the quadruple visual analog scale was not specifically designed for scoliosis patients. However, it does provide an easy-to-collect dataset from which to evaluate treatment impact on pain levels. Future studies should include quality of life indices specifically designed for the scoliosis patient population.

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The authors declare none.

Conflicts of Interest

MWM has applied for design and utility patents in the USA on the scoliosis activity suit. The remaining authors declare no conflicts of interest.

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