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ORIGINAL ARTICLE

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Health-related quality of life in patients with adolescent idiopathic scoliosis after treatment: short-term effects after brace or surgical treatment

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Abstract For treatment of teenagers with progressive adolescent idiopathic scoliosis in an early stage, two options are generally considered: treatment with a brace or observation followed by surgery if necessary. Many doctors and patients prefer conservative treatment (i.e. brace treatment) to surgical treatment, because surgery of the spine is generally considered a drastic intervention. Because potential differences in health-related quality of life (HRQoL) after treatment between braced and surgically treated patients are not well explored, this study aimed to determine whether short-term differences exist in HRQoL between adolescents treated with a brace or treated surgically. A cross-sectional analysis of HRQoL was made of 109 patients with adolescent idiopathic scoliosis who, after completing treatment, filled out the Dutch SRS-22 Patient Questionnaire. All patients had been treated either with a brace or surgery, or with a brace followed by surgery. Patients treated surgically had significantly higher mean scores in the satisfaction with management domain than those treated with a brace. No other consistent differences in HRQoL were found between patients treated with a brace and patients treated surgically. Gender, curve type and curve size had no relevant effect on HRQoL. We conclude that short-term differences in HRQoL after treatment in adolescent patients with idiopathic scoliosis are negligible and cannot support preference of one treatment above the other.

Keywords Quality of life · Adolescent idiopathic scoliosis · Brace · Surgery

Introduction

For treatment of teenagers with progressive adolescent idiopathic scoliosis (AIS) in an early stage, two options are generally considered: treatment with a brace or observation followed by surgery if necessary. In practice, some patients treated with a brace will eventually also need surgical treatment [18]. Many doctors and patients prefer conservative treatment (i.e. brace treatment) to surgical treatment, because surgery of the spine is gen-

erally considered a drastic intervention. The risk of damage of the spinal cord during such operations is often emphasized although, at present, that risk may be considered relatively small (less than 0.5%) [19].

The debate about the best option remains undecided [10–12, 17]. Besides clinical outcomes, health-related quality of life (HRQoL) is an important measure in evaluating treatment, especially in non-life-threatening conditions [13, 16]. Therefore, potential differences in HRQoL after treatment between conservatively treated and surgically treated patients can also be considered. Some information is available on long-term follow-up in AIS, but study results are not unanimous. Weinstein et al. [21] concluded in a 50-year natural history study of untreated patients with late onset idiopathic scoliosis (LIS) that untreated LIS causes little physical impairment other than back pain and cosmetic concerns, and causes no increase in clinical depression compared to controls. Ascani et al. [1] on the other hand, found no increased incidence of pain, but found real psychological disturbances in 19% of untreated AIS patients. With respect to long-term follow-up on HRQoL in conservatively treated patients, Danielsson et al. concluded that minimal pain occurred compared with normal controls [8] and that psychosocial well-being is quite good 20 years after brace or surgical treatment and is equal to the general population [9]. However, at the start of the 21st century with changing adolescent culture and experience, it is important to keep evaluating HRQoL in new AIS patient groups.

Measuring HRQoL in idiopathic scoliosis patients is feasible. Haher et al. [14] designed the Scoliosis Research Society (SRS) Outcome Instrument, which is a simple, disease-specific, patient-based assessment. Modifications of this instrument resulted in the SRS-22 Patient Questionnaire that covers the domains of function/activity, pain, self-image/appearance, mental health and satisfaction with management. This instrument has proved to be reliable [4], reproducible [4], valid [4], discriminative [2] and responsive to change [3]. In Spain, the SRS-22 has been translated into Spanish, which resulted in an instrument apparently equivalent to the original version and suitable for clinical research [5, 7].

We studied the SRS-22 Patient Questionnaire outcomes in adolescents who had completed brace treatment or surgical treatment. The aim of this study was to determine if there were short-term differences in HRQoL between adolescents treated with a brace and those treated surgically.

Materials and methods

The Regional Medical Ethical Review Board approved this study.

Study population

Orthopaedic surgeons from 12 hospitals in the Netherlands where patients with AIS are treated were requested to report all consecutive patients who had completed their treatment between June 2002 and September 2004 ($n = 143$). Of these patients, 122 gave their informed consent and were invited, without incentives, to participate in this study; 109 agreed to do so.

The total research group ($n = 109$) consisted of two separate subgroups; patients treated with a brace (B group, $n = 45$) and patients treated surgically (S group, $n = 64$). Brace treatment consisted of a Boston brace, and in five patients additionally a TriaC brace. In the Netherlands, orthopaedic surgeons usually recommend surgery when the Cobb angle reaches 40–45° and further growth of physical height is still expected. All patients had completed treatment; patients in the B group were not expected to be eligible for surgical treatment in the future, as far as could be judged at time of inclusion based on curve characteristics and cessation of growth. In the surgery group, 31 patients were treated with a brace before surgery (BS group) and 32 patients were treated only surgically (OS group); separate analyses were made for those two latter groups.

In the brace group, 12 patients had a single thoracic curve, 9 a single thoracolumbar curve, 5 a single lumbar curve, 1 a double thoracic curve and 15 had a double thoracic lumbar curve (data on curve type of three patients were missing). In the surgery group, 17 patients had a single thoracic curve, 16 a single thoracolumbar curve and 28 had a double thoracic lumbar curve (data on curve type of three patients were missing). To optimise similarity of the brace and surgery group, we only used data from patients with thoracic, thoracolumbar and double thoracic lumbar curves for the analysis, because these curves were almost equally distributed in the two study groups.

Table 1 shows the characteristics of the study population. Mean Cobb angles were calculated using the largest thoracic, thoracolumbar or lumbar component. At first visit the Cobb angle was 24° (±8.5) in the B group, 34° (±12.6) in the BS group, 43° (±14.5) in the OS group and 39° (±14.3) in the S group [differences are significant between B group and BS group ($P < 0.01$), B group and OS group ($P < 0.01$), B group and S group ($P < 0.01$) and BS group and OS group ($P < 0.05$)]. The Cobb angle before surgery was 56° (±10.7) in the BS group, and 52° (±8.3) in the OS group (difference not significant). The Cobb angle after treatment was 33° (±8.6) in the B group, 34° (±13.3) in the BS group, 30° (±11.1) in the OS group and 32° (±12.2) in the S group (differences between these groups are not significant).

Table 1 Characteristics of the study population

	Total ($n=97$), mean (SD)	Brace ($n=36$; B group), mean (SD)	Brace and surgery ($n=31$; BS group), mean (SD)	Only surgery ($n=30$; OS group), mean (SD)	Surgery total ($n=61$; S group), mean (SD)
Age (in years) at filling out SRS-22	16.3 (1.6)	16.6 (1.3)	16.2 (1.9)	16.1 (1.6)	16.1 (1.8)
Girls[a]	78 (80%)	32 (89%)	23 (74%)	23 (77%)	46 (75%)
Boys	19 (20%)	4 (11%)	8 (26%)	7 (23%)	15 (25%)
Total bracing period (months)	24.3 (28.0)	38.7 (23.7)	32.6 (30.8)	NA	16.4 (27.1)
Cobb angle at first visit to orthopaedic surgeon (°)[b]	33 (14.3)	24 (8.5)†,‡,§	34 (12.6)$^{\dagger,\#}$	43 (14.5)$^{\ddagger,\#}$	39 (14.3)§
Cobb angle after treatment (°)[b]	32 (10.6)	33 (8.6)	34 (13.3)	30 (11.1)	32 (12.2)
Cobb angle pre-surgery (°)[b]	54 (9.5)	NA	56 (10.7)	52 (8.3)	54 (9.5)
Thoracal curve	29 (30%)	12 (33%)	6 (19%)	11 (37%)	17 (28%)
Thoracolumbar curve	25 (26%)	9 (25%)	7 (23%)	9 (30%)	16 (26%)
Double curve[c]	42 (44%)	15 (42%)	18 (58%)	10 (33%)	28 (46%)

NA not applicable
$^{\dagger,\ddagger,\S}P<0.01$, $^{\#}P<0.05$
[a]All groups have significantly more girls than boys
[b]On average, 71% of the Cobb angles were available
[c]Double curves were only thoracic lumbar curves

Measurements

All participants received a Dutch version of the SRS-22 Patient Questionnaire by mail, and were requested to fill out the questionnaire themselves. Time span between completing treatment and filling out the questionnaire was completely random; on average, patients of the B group filled out the questionnaire 11 months after completing brace treatment (range 0–27 months), and patients of the S group 10 months after surgery (range 0–28 months).

Three members of the research team (native Dutch speakers) individually translated the original SRS-22 questionnaire into Dutch. On the basis of these three translations they formed consensus on one version that was back translated into English by a native English speaker. The back translation and the original version were compared and appeared to be similar; after some minor changes, the Dutch version was finalised.

We added one question about general health (''How is your health status now?'' on a scale from 0 to 100 where 100 indicates the best possible health status and 0 indicates the worst possible health status) using the visual analogue scale (VAS) [6].

The Dutch version of the SRS-22 Patient Questionnaire was pre-tested on 47 patients who were also either treated with a brace or surgically, or with a brace followed by surgery. These patients had completed treatment between January 2001 and June 2002, thus before the inclusion period of this study. There were no floor effects, and ceiling effects were in general smaller than in the original version and the Spanish version. Chronbach's alphas were adequate to excellent (function/activity 0.74; pain 0.75; self-image 0.85; mental health 0.90; satisfaction with management 0.71 and total score 0.93) and comparable with the original and Spanish version.

Additionally, the orthopaedic surgeons were given the opportunity to express their personal satisfaction with management for a patient, recorded on a five-point scale (from very satisfied to very unsatisfied).

Statistical analyses

Mean domain scores and VAS score were calculated for the total group and for all subgroups. For the SRS-22 scores, we used non-parametric tests because SRS-scales are not continuous and show ceiling effects. Furthermore, some scales were skewed. The Mann–Whitney *U* test was used for the evaluation of significant differences in median domain scores of the SRS-22. Spearman's rank order correlation coefficients were applied to evaluate correlations between SRS-22 scores and time span between completing treatment and filling out the questionnaire. The patients and the surgeons' opinion about satisfaction with management were evaluated and were tested for significant differences by the Wilcoxon Signed Ranks test. Level of significance was defined as alpha < 0.05.

SPSS 11.0.1 was used for the analyses.

Results

There were no significant correlations between the Cobb angles after treatment and SRS-22 scores within the total group, or within the B and S group. Boys and girls showed

Table 2 Mean (SD) SRS-22 scores for the Dutch, original and Spanish version

Domain	*n*	Median	Dutch version, mean (SD)	Original version [4] ($n = 58$), mean (SD)	Spanish version [5] ($n = 175$), mean
Function/activity					
Total	97	4.2	4.1 (0.54)		4.2
Brace	36	4.4	4.3 (0.51)†,‡,§		
Brace and surgery	31	4.0	3.9 (0.55)†		
Only surgery	30	4.0	4.0 (0.52)‡		
Surgery, total	61	4.0	3.9 (0.53)§	4.2 (0.64)	
Pain					
Total	97	4.4	4.2 (0.75)		4.4
Brace	36	4.7	4.5 (0.57)$^{\P,\#}$		
Brace and surgery	31	4.4	4.1 (0.90)		
Only surgery	30	4.2	4.1 (0.71)¶		
Surgery, total	61	4.4	4.1 (0.81)$^{\#}$	4.2 (0.85)	
Self-image/appearance					
Total	97	4.0	4.0 (0.50)		3.9
Brace	36	3.8	3.9 (0.49)¶		
Brace and surgery	31	4.0	3.9 (0.47)$^{\#}$		
Only surgery	30	4.2	4.1 (0.52)$^{\P,\#}$		
Surgery, total	61	4.0	4.0 (0.51)	4.2 (0.60)	
Mental health					
Total	96	4.0	4.0 (0.64)		4.0
Brace	36	4.2	4.1 (0.72)		
Brace and surgery	31	4.0	4.0 (0.60)		
Only surgery	29	4.0	4.0 (0.61)		
Surgery, total	60	4.0	4.0 (0.60)	4.1 (0.76)	
Subtotal score					
Total	97	4.1	4.1 (0.45)		
Brace	36	4.2	4.2 (0.41)		
Brace and surgery	31	4.0	4.0 (0.50)		
Only surgery	30	4.1	4.1 (0.43)		
Surgery, total	61	4.1	4.0 (0.46)		
Satisfaction with management					
Total	97	4.5	4.2 (0.79)		4.4
Brace	36	4.0	3.8 (0.70)†,‡,§		
Brace and surgery	31	4.5	4.3 (0.86)†		
Only surgery	30	5.0	4.7 (0.56)‡		
Surgery, total	61	5.0	4.5 (0.74)§	4.5 (0.80)	
Total score					
Total	97	4.1	4.1 (0.44)		
Brace	36	4.1	4.1 (0.41)		
Brace and surgery	31	4.1	4.0 (0.49)		
Only surgery	30	4.3	4.2 (0.43)		
Surgery, total	61	4.2	4.1 (0.46)		

$^{\dagger,\ddagger,\S}P < 0.01$, $^{\P,\#}P < 0.05$

no significant differences in SRS-22 domain scores within the total group, or within the B and S group. In the total group, patients with thoracolumbar curves had worse function scores than patients with thoracic curves ($P < 0.05$), and patients with thoracic lumbar curves were less satisfied with management than patients with thoracolumbar curves ($P < 0.05$). In the surgery group, patients with thoracic lumbar curves were less satisfied with management than patients with thoracolumbar curves ($P < 0.01$). There were no differences in SRS-22 scores between curve types within the brace group.

In the total group, there is a weak but significant correlation between individual improvement in Cobb angle and satisfaction with management (spearman's rho −0.39, $P < 0.01$). This means that patients who improved most in Cobb angle were more satisfied with management. Although, neither in the B group nor in the S group this correlation was significant, Spearman's rho was much higher in the S group than in the B group (−0.30 vs. 0.01). No other correlation between improvement in Cobb angle and SRS-22 scores were found.

On four domains differences were found between the treatment groups. Table 2 shows that patients of the B group had a significantly better mean function score than the BS group, the OS group and the S group. The OS and S group had significantly more pain than the B group. The OS group had significantly better mean self-image/appearance scores than the B group and the BS group. The BS group, the OS group and the S group were significantly more satisfied with management than the B group.

Table 2 also shows that data are comparable to (more limited) data of two earlier international studies [4, 5].

Table 3 Spearman's correlations between SRS-22 scores and time span between completing treatment and filling out the questionnaire

Domain	Time span between completing treatment and filling out SRS-22			
	Brace group ($n = 36$; B group), Spearman's rho	Brace and surgery ($n = 31$; BS group), Spearman's rho	Only surgery ($n = 30$; OS group), Spearman's rho	Surgery group ($n = 61$; S group), Spearman's rho
Function/activity	−0.15	0.47*	0.54*	0.50*
Pain	−0.01	0.22	0.27	0.23
Self-image/appearance	−0.11	−0.09	−0.08	−0.03
Mental health	−0.18	0.20	0.25	0.23
Subtotal score	−0.15	0.27	0.32	0.30**
Satisfaction with management	−0.12	−0.21	0.19	0.03
Total score	−0.13	0.19	0.35	0.27**

*$P < 0.01$; **$P < 0.05$

Table 4 Single-item general health, scale 0–100

Group	*n*	Median	Mean (SD)
Total	94	85	83.8 (11.4)
Brace (B group)	35	82	83.3 (12.4)
Brace and surgery (BS group)	30	80*	80.9 (11.8)
Only surgery (OS group)	29	90*	87.6 (8.9)
Surgery total (S group)	59	85	84.1 (10.9)

*$P < 0.05$

Significant correlations between time span between completing treatment and filling out the questionnaire and function, subtotal and total scores were found only in the surgery (sub)group(s) (Table 3). Patients with a longer time span had better scores. Within the brace group there were no significant correlations between time span and SRS-22 scores.

There is a significant interaction effect of time span and treatment group on function scores ($P < 0.01$). However, sub-analysis showed no significant differences in function scores between patients of the B group and the S group who filled out the questionnaire at least 12 months after completing treatment (data not shown). For pain, self-image/appearance, mental health and satisfaction with management, no interaction effects of time span and treatment group were found.

The single-item general health measure (VAS score) showed significant differences only between the BS group and the OS group (Table 4). The OS group had the highest mean score.

For 10 patients in the brace group and 32 patients in the surgery group, the orthopaedic surgeons' opinion about satisfaction with management results was recorded. Orthopaedic surgeons were more satisfied with management results in patients treated with a brace than the patients themselves (although the difference was not significant). In patients treated surgically, the opinion of the orthopaedic surgeon about management results was in accordance with the opinion of the patients (Table 5).

Discussion

Patients treated surgically were much more satisfied with management than patients treated with a brace, despite Cobb angles after treatment being quite similar in both groups. This difference may partly be attributed to the fact that patients treated surgically had an improved Cobb angle (from 54° before surgery to 32° after surgery), while patients treated with a brace had a larger Cobb angle at the end (32°) than at the first visit to the orthopaedic surgeon (24°). However, this difference in satisfaction cannot only be explained by improvement of

Table 5 Patients' and surgeons' reports on a five-point scale on satisfaction with management

Satisfaction with management	*n*	Patients		Surgeons		*P* value
		Median	Mean (SD)	Median	Mean (SD)	
Brace (B group)	10	4.0	3.9 (0.99)	5.0	4.6 (0.70)	NS
Brace and surgery (BS group)	15	5.0	4.5 (0.74)	5.0	4.4 (0.74)	NS
Surgery only (OS group)	17	5.0	4.8 (0.39)	5.0	4.5 (1.18)	NS
Surgery total (S group)	32	5.0	4.7 (0.60)	5.0	4.4 (0.98)	NS

NS not significant

Cobb angle, since we only found a weak correlation between improvement in Cobb angle and satisfaction in the S group. Climent et al. [7] also found that patients treated with a brace were less satisfied with management than patients treated surgically. A similar trend was seen in a study by Danielsson et al. [9] on HRQoL after follow-up of at least 20 years in patients treated with a brace and patients treated surgically; they reported a more negative effect of the treatment period on patients treated with a brace than on patients treated surgically, but in that study different measures were used than in our study.

Furthermore, in the present study, patients treated only surgically had highest scores on the self-image/appearance domain and on the single-item general health; although significant, these differences were rather small (respectively, 0.2 points on a 5-point scale and 7 points on a 100-point scale). In our study, patients scored around four points on a five-point scale in the self-image/appearance domain, which implies that these patients were satisfied. Weinstein et al. [21] concluded in their study that untreated AIS patients had cosmetic concerns. Although different measures were used, it seems that treated patients are more satisfied with self-image than untreated patients. However, it is important to know that Cobb angles of the untreated patients in the study by Weinstein et al. were much larger than Cobb angles in our study population.

Patients treated with a brace had a significantly higher mean score in the function/activity domain than patients treated surgically (whether or not being braced before surgery). However, there is a positive correlation between time span between surgery and filling out the questionnaire and function scores in the surgery group; after a longer time span function scores are higher (i.e. better), and there were no significant differences in function scores between patients of the B group and the S group who filled out the questionnaire at least 12 months after completing treatment. Obvious reasons for this short-term difference are that patients are recovering from a major operation and that initial restrictions in the patients' physical activities, enforced by their surgeon, are no longer required 6–12 months after surgery. These reasons might also explain the worse pain scores found in the surgery group. These findings are in accordance with the findings of Asher et al. [3] in their study of responsiveness of change.

In line with our results, other studies also found no major impact of gender [7, 15, 20], Cobb angle [7, 9] and curve type [2, 7, 9] on HRQoL after treatment.

In patients treated with a brace, orthopaedic surgeons who recorded their satisfaction with management were more satisfied than the patients themselves (difference not significant). A reason for this could be that patients have a different expectation about outcome than their orthopaedic surgeon. If this is the case, patients should be better informed about possible outcomes. However, surgeons agreed about management results with patients treated surgically. Although not all surgeons expressed their opinion about satisfaction with management for all their patients, this result supports the finding that patients treated with a brace are less satisfied with management than patients treated surgically.

Although the SRS-22 is not fully validated for children younger than 18-years old, mean domain scores in the present study corresponded with mean domain scores found by Asher et al. [4] and Bago et al. [5]. Chronbach's alphas in the Dutch version were good to excellent and comparable with the original version, there were no floor effects and there were less ceiling effects than in the original version. For complete validation of the Dutch version of the SRS-22 Questionnaire, test-retest reliability and responsiveness to change should be further evaluated.

Our design was limited to a cross-sectional assessment after treatment. It means we were not able to evaluate whether differences in HRQoL between the groups existed before treatment, nor were we able to evaluate whether these possible differences had influenced the results after treatment. For instance, patients in the brace group and the surgery group differ in some respects, e.g. Cobb angle at baseline differed significantly between the brace group and the surgery group. This difference is probably also responsible for different expectations and management issues and might have influenced HRQoL, and in particular satisfaction with management. Longitudinal data on different treatment groups (i.e. under observation, brace treatment or surgery) could provide more insight into the impact of baseline characteristics, management issues and expectations on HRQoL.

Conclusions

In conclusion, the idea that conservative treatment is to be preferred to surgical treatment is not supported by differences in HRQoL after treatment in our adolescent patients with idiopathic scoliosis. On the contrary, patients treated with a brace were less satisfied with management results than patients treated surgically. At the start of the 21st century with changing adolescent culture and experience, such perceptions are very important in this particular phase in a teenager's life.

These findings should be taken into account in the debate about the preferred option for treatment in AIS. Other issues are also important in this discussion, especially regarding a decisive conclusion about the degree of effectiveness of bracing [11, 17]. Concerning HRQoL, further research on this debate should also focus on quality of life during brace treatment or observation, the

pre-surgery period and on the long-term follow-up after treatment, because short-term results are important, but not conclusive.

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