Role of rod diameter in comparison between only screws versus hooks and screws in posterior instrumentation of thoracic curve in idiopathic scoliosis

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Abstract Since the introduction of Cotrel–Dubousset instrumentation in 1984, the correction techniques in scoliosis surgery have changed from Harrington principles of concave distraction to segmental realignment to a variety of possibilities including the rod rotation manoeuvres, and to segmental approximation via cantilever methods. Additionally, pedicle screw utilization in lumbar curves enhanced correction and stabilization of various deformities, and various studies have strongly supported the clinical advantages of lumbar pedicle screws versus conventional hook instrumentation. Pedicle screw constructs have become increasingly popular in the treatment of patients with spinal deformity. When applied to adolescent idiopathic scoliosis patients, pedicle screw fixation has demonstrated increased corrective ability compared with traditional hook/hybrid instrumentation. In our study, we do a retrospective review of idiopathic scoliosis patients (King 2–Lenke 1 B/C) treated with a selective thoracic posterior fusion using an all-screw construct versus a hybrid (pedicle screws and hooks) construct and, compare the percentage of correction of the scoliotic curves obtained with screws alone and screws and hooks. Special attention was given to the rod diameter and correction technique. Our results show that the percentage of correction of idiopathic thoracic scoliosis is similar when treating the scoliosis with rods and screws alone or with rods, screws and hooks; therefore, we and the majority of

authors in the literature do not consider the rod section. This can be an important parameter in the evaluation of the superiority of treatment with screws only or screws and hooks. In our study, even if not of statistical significance, the better thoracic curve correction obtained with the hybrid group should be ascribed to the fact that in this group mostly 6 mm rods were used.

Keywords Adolescent idiopathic scoliosis · Thoracic pedicle screws · Thoracic hooks · Rod diameter · Selective thoracic posterior fusion

Introduction

Since the introduction of Cotrel–Dubousset instrumentation in 1984, the correction techniques in scoliosis surgery have changed from Harrington principles of concave distraction to segmental realignment to a variety of possibilities including the rod rotation manoeuvres, and to segmental approximation via cantilever methods [1–6]. Additionally, pedicle screw utilization in lumbar curves enhanced correction and stabilization of various deformities, and various studies have strongly supported the clinical advantages of lumbar pedicle screws versus conventional hook instrumentation [7–9]. Pedicle screw constructs have become increasingly popular in the treatment of patients with spinal deformity. When applied to adolescent idiopathic scoliosis patients, pedicle screw fixation has demonstrated increased corrective ability compared with traditional hook/hybrid instrumentation [10–14].

In our study, we do a retrospective review of idiopathic scoliosis patients (King 2–Lenke 1 B/C) treated with a selective thoracic posterior fusion using an all-screw

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construct versus a hybrid (pedicle screws and hooks) construct, and compare the percentage of correction of the scoliotic curves obtained with screws alone and screws and hooks. Special attention was given to the rod diameter and correction technique.

Materials and methods

A continuous series of 36 King 2–Lenke 1 B/C idiopathic scoliosis patients was retrospectively included in the present study.

Eighteen patients with a major thoracic idiopathic scoliotic curves (screw group: Table 1) treated between 2006 and 2008 with screws alone and 18 similar thoracic idiopathic scoliotic curves (hybrid Group: Table 1) treated between 2003 and 2005 with hooks and screws were retrospectively evaluated.

Radiographic measurements

Measurements were made on 36-inch-long cassette anteroposterior and lateral radiographs of the spine with the patient standing. All the radiographic measurements were made manually by two of the authors, independent of the operative team. Radiographic analysis included Cobb angle measurements of the thoracic and lumbar curves on the preoperative and early postoperative (within 1 week) radiographs. For each group, the percentage of reduction of the dorsal and lumbar curves between the preoperative and postoperative radiographs was measured. Results were statistically compared with the two-tailed Student *T* test.

Operative procedure

Selective thoracic posterior instrumented fusions were performed by the same senior surgeon with the technique of the segmental derotation for the correction made with screws and hooks and with the technique of the global derotation (Cotrel Dubousset) for the correction made with screws alone (Tables 2, 3 show the number of the screws and hooks and the diameter of the rods utilized for each patient).

Table 1 Screw vs hybrid groups

Screw	
Sex	M:F = 6:12
Age	16.67 (11–35)
Hybrid	
Sex	M:F = 2:16
Age	18.11 (11–39)

Table 2 Screw group

	Sex	Age	Screws	Hooks	Rod
1	F	16	10	0	5.5
2	F	16	10	0	5.5
3	F	12	10	0	5.5
4	F	12	10	0	5.5
5	M	15	10	0	6
6	F	15	11	0	6
7	F	34	10	0	5.5
8	F	13	8	0	5.5
9	M	17	11	0	6
10	M	35	10	0	6
11	F	13	9	0	5.5
12	F	14	10	0	6
13	F	12	10	0	6
14	F	12	10	0	5.5
15	M	21	10	0	5.5
16	M	17	10	0	5.5
17	F	11	10	0	6
18	M	15	10	0	5.5

Table 3 Hybrid group

	Sex	Age	Screws	Hooks	Rod
1	F	11	4	7	6
2	F	16	4	6	6
3	F	17	4	5	6
4	F	16	4	7	6
5	F	12	4	8	5
6	F	12	4	7	5
7	M	23	4	10	6
8	F	13	4	8	5
9	F	13	4	6	6
10	F	16	4	6	6
11	F	24	4	7	6
12	F	19	4	7	6
13	F	21	4	7	6
14	F	28	4	6	6
15	F	17	4	10	6
16	F	15	4	7	6
17	F	39	4	6	6
18	M	14	4	6	6

The choice of the instrumented vertebrae was the same for all patients: four pedicular screws for the two distal vertebrae, two hooks or screws at the apical vertebra and a couple of screws or hooks for the cranial vertebra. The intermediate vertebrae were instrumented with hooks in the concavity or screws bilaterally. A claw was put in the

convexity of the curve on the vertebra below the cranial one in the hybrid group (Figs. 1, 2, 3).

Posterior screw constructs consisted of 5.5 or 6 mm rod-based instrumentation (5.5 mm: Legacy Medtronic and Expedium DePuy; 6 mm: USS Synthes), while the hybrid constructs consisted of 5 or 6 mm rod-based instrumentation (5 mm: USS Synthes pediatric; 6 mm USS Synthes).

Fig. 1 On the *left*, hybrid instrumentation. On the *right*, screw instrumentation. Four pedicular screws for the two distal vertebrae, two hooks or screws at the apical vertebra and a couple of screws or hooks for the cranial vertebra. The intermediate vertebrae were instrumented with hooks in the concavity or screws bilaterally. A claw was put in the convexity of the curve on the vertebra below the cranial one in the hybrid instrumentation

The bent rods in the screw group were placed at the concave and the convex side in all patients and the curve correction was achieved with global derotation, posterior constructs in screw group consisted mostly 5.5 mm rods (Table 2). Posterior constructs in the hybrid group consisted mostly 6 mm rods (Table 3); the concave rod was placed first. Correction was obtained with segmental derotation.

Results

Demographic data (sex and age) and preoperative thoracic and lumbar Cobb values did not differ significantly between the groups (Table 1). No patients were braced after surgery and the total instrumented vertebrae did not vary significantly between the groups: screw group 8.33, hybrid group 9.22, $p = 0.97$ (Tables 4, 5).

In the screw group, the mean value of the angular deformity preoperatively was 51.22° for the thoracic curve and 34.33° for the lumbar one. After surgical treatment the mean values were, respectively, 19.28° and 15.78° with a global thoracic correction of 62.87% and a lumbar one of 56.27%. In the hybrid group, the preoperative angular deformity was 52.61° for the thoracic curve and 38.83° for the lumbar curve. The postoperative angular values were 18.56° for the thoracic curve and 17.67° for the lumbar one; global correction percentages were, respectively, 64.70 and 55.13%. Postoperative thoracic and lumbar percentages of correction in the two groups were compared with the two-tailed Student *T* test, and did not show a difference relevant statistically (thoracic curve $p = 0.49$; lumbar curve $p = 0.39$). Our results are resumed in Tables 4, 5 and 6.

Fig. 2 Eleven-year-old girl, King 2, Lenke 1 C. Screw group (6 mm rod, 10 screws). Thoracic correction 66%, lumbar correction 52%

Fig. 3 Eleven-year-old girl, King 2, Lenke 1 B. Hybrid group (6 mm rod, seven hooks and four screws). Thoracic correction 66%, lumbar correction 68%

Table 4 Screw group

Parameter	Mean	DS
Instrumented vertebrae	8.33	0.84
Preop. thoracic angle (°)	51.22	7.64
Postop. thoracic angle (°)	19.28	7.70
Thoracic correction (%)	62.87	13.97
Preop. lumbar angle (°)	34.33	9.27
Postop. lumbar angle (°)	15.78	9.08
Lumbar correction (%)	56.27	18.00

Table 5 Hybrid group

Parameter	Mean	DS
Instrumented vertebrae	9.22	1.40
Preop. thoracic angle (°)	52.61	9.64
Postop. thoracic angle (°)	18.56	6.61
Thoracic correction (%)	64.70	12.78
Preop. lumbar angle (°)	38.83	12.27
Postop. lumbar angle (°)	17.67	8.60
Lumbar correction (%)	55.13	19.64

Table 6 Comparison between screw and hybrid groups

Parameter	Screw	Hybrid	<i>p</i>
Thoracic correction (%)	62.87	64.70	0.49
Lumbar correction (%)	56.27	55.13	0.39

Discussion and conclusion

The goal of spinal deformity surgery continues to be to achieve a balanced spinal fusion. The strategies of achieving this have evolved from nonsegmental rod

systems, to segmental wire fixation, to segmental hook fixation, and most recently to segmental screw fixation [1–6]. Segmental fixation systems are currently the gold standard, and all are designed to correct deformity in both the frontal and sagittal planes while optimizing fusion rates. Pedicle screws offer three-column purchase and a longer moment arm compared with hook placement on the lamina [15]. Instrumentation of each vertebral level with pedicle screws on the correcting side allows a more rigid fixation and reduces the stress-concentration on any one particular screw during manipulation [13, 14]. This method also allows control of each instrumented segment including the apex of the curve, which allows selective intersegmental compression, distraction, translation, and rotation. Although technically demanding, pedicle screw insertion techniques have been reported to provide good accuracy in placing the screws without major neurologic complications [14, 16–23].

Our results show that the percentage of correction of idiopathic thoracic scoliosis is similar when treating the scoliosis with rods and screws alone or with rods, screws and hooks; therefore, we and the majority of authors in the literature do not consider the rod section. This can be an important parameter in the evaluation of the superiority of treatment with screws only or screws and hooks. Therefore, in the majority of the papers published, both the surgical technique and the rod diameter are not considered. The rod section is important during the manoeuvres of the correction, and even more so in maintaining it. Dobbs et al. [11] compared only the screw group and hook group with the same 5.5 mm rods and concluded that selective thoracic fusion of main thoracic-compensatory lumbar C modifier AIS curves with pedicle screws allowed for better thoracic correction and less postoperative coronal decompensation than seen with hooks. Unfortunately, in our study we used eleven 5.5 mm rods and seven 6 mm rods in the screw group and three 5 mm and fifteen 6 mm rods in the hybrid

group: these data must be considered in the evaluation of our results. Table 6 shows that the corrections of the thoracic and lumbar curves in the two groups do not have statistical significance ($p = 0.49$ and $p = 0.39$, respectively) and that there is no difference between the two surgical procedures. We think, however, that, even if not of statistical significance, the better thoracic curve correction obtained with the hybrid group should be ascribed to the fact that in this group mostly 6 mm rods were used. The longer instrumentation in hybrid group (9.22 vs. 8.3) could be one more reason for the better curve correction in this group, even if both are not statistically significant. Moreover, to achieve more homogeneous results, the surgical technique should be the same in the two groups.

Conflict of interest None.

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