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ORIGINAL STUDY

Sublaminar devices for the correction of scoliosis : metal wire versus polyester tape

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The authors conducted a retrospective study comparing the corrective effect of two sublaminar techniques on scoliosis : the classical one, based on metal wire, and a more recent one, based on polyester tape (thoracic Universal Clamp), known to be safer (less risk of neurological damage, less laminar breakthrough) and compatible with MRI. Lumbar screws were used in both groups. The authors composed two groups of 25 scoliosis patients, matched for gender, age, aetiology, anterior release, number of levels fused, number of infections, major curve and flexibility : there was no significant difference. Only the follow-up period was different : 55 months in the metal wire group, versus 17 months in the polyester tape group ($p < 0.001$), but this was immaterial because the curves were compared one year after surgery. After one year there was no significant difference between both groups, as to correction in the coronal or in the sagittal plane. This means that the polyester tape technique offers an interesting alternative, given that it yields supplementary advantages, as mentioned above.

Keywords : hybrid constructs ; sublaminar metal wire ; sublaminar polyester tape ; Universal Clamp ; idiopathic scoliosis ; neuromuscular scoliosis ; cerebral palsy scoliosis.

INTRODUCTION

The surgical treatment of spinal deformities has significantly changed since the introduction of non-segmental instrumentation by Harrington (*4*). In 1982 Luque (*10*) reported on segmental instrumentation using monofilament metal wires. Later on, new techniques were developed such as the Cotrell-Dubousset instrumentation, the Isola instrumentation and the transpedicular screw instrumentation. The use of transpedicular screws in the lumbar spine is now widely accepted. However, discussion remains as to which instrumentation to use in the thoracic spine. Since Winter *et al* (*16*) stressed that correction in the sagittal plane is important as well as correction in the frontal plane, the use of hybrid constructs with sublaminar wires or hooks in the thoracic spine, and pedicle screws at the lumbar level, gained more interest. Hybrid constructs like the Isola system, which comprises pedicle screws, hooks and sublaminar metal wires, are known to offer excellent curve correction, not only in the frontal plane but also in the sagittal plane. However, spinal cord injuries and section of the lamina may occur

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during insertion or removal of the metal wires (*1,15*). Curve progression following wire breakage has also been described (*13*). Last but not least, sublaminar wires in stainless steel are incompatible with MRI (*3*).

Therefore a technique which would yield the advantages but not the disadvantages of the sublaminar wire system would be ideal. A new implant was proposed : the Universal Clamp (Abbott Spine, Bordeaux, France ; distributed by Zimmer spine). It consists of a polyester belt or tape and a titanium or stainless steel clamp. The belt rounds the lamina and is connected to the spinal rod by the clamp. The soft polyester belt has less potential to cause spinal cord injuries, especially when it is removed during revision surgery (*6,11*). Moreover, polyester allows the use of MRI.

The purpose of this study was to retrospectively compare the coronal and sagittal corrective abilities of conventional metal wires and polyester tapes (Universal Clamp). Both techniques achieve correction via posteromedial translation. Studies comparing both techniques are rare (*13*).

MATERIALS AND METHODS

Patients

Approval was obtained from the institutional medical ethics committee. All patients were selected from a single database. Two groups of 25 patients were composed. They were matched for gender, aetiology, age, anterior release, number of fused levels, number of infections (Table I), major curve and flexibility (Table II) : significant differences were not seen. Only the follow-up period was different : 55 months in the metal wire group, versus 17 months in the polyester tape group ($p < 0.001$), but this was immaterial because the curves were compared one year after surgery. All patients were evaluated before surgery, early postoperatively, at 3 months and at one year after surgery. A minimum follow-up of one year was required. No patient had undergone previous spinal surgery. This retrospective study was based on prospectively collected data in the context of a normal follow-up.

Radiographic measurements

All measurements were made by a single observer (PC) on 36-inch long-cassette coronal and lateral radiographs of the spine, with the patient standing. The Cobb angle of the major and minor curves was measured preoperatively, early postoperatively (within 2 months), and after one year. Curve flexibility was determined on the preoperative supine side bending films. The thoracic kyphosis was evaluated on the lateral radiographs, from the upper endplate of T5 to the lower endplate of T12 ; the lumbar lordosis from the lower endplate of T12 to the upper endplate of S1.

Statistical Analysis

Distributions of variables are given as means, standard deviations (SD), and ranges. Comparisons between the two groups were performed using Student's t test and the Mann-Whitney U test. All statistical tests were 2-tailed, and a p value < 0.05 was considered to be significant. All analyses were performed using SAS software, version 9.2 of the SAS System for Windows. The copyright© 2002 SAS Institute Inc. SAS, and all other SAS Institute Inc. product or service names, were registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

Table I. — Demographics

	Metal wire (N = 25)	Tape (N = 25)	*p*
Gender	12 females/ 13 males	17 females/ 8 males	0.252
Aetiology	9 idiopathic, 11 CP, 5 neuromuscular	9 idiopathic, 8 CP, 8 neuromuscular	0.596
Age at surgery	15 ± 1.9	15.9 ± 3,8	0.761
Anterior release	3	3	1.000
Nb levels fused	15 ± 2.3	15 ± 2.1	0.770
Infections	1	1	< 0.001*
Follow-up	55 ± 13.7	17 ± 4.4 one	1.000

* *Statistically significant.*

Table II. — Comparison in frontal and sagittal plane

	wire group	tape group	*p*
Major curve Cobb angle			
Preop	62.3° ± 16,6	63.6° ± 20.7	0.808
Flexibility	44.6° ± 14.6	41.6° ± 17.4	0.505
Early postop.	31.9° ± 12.3	30.6° ± 10,6	0.679
At final follow-up (1y)	34.8° ± 11.1	34.5° ± 9.2	0.889
p preop vs final follow-up	<0.001*	<0.001*	
Thoracic kyphosis			
Preop	29.1° ± 16.2	25.7° ± 19.0	0.501
Early postop.	25.1° ± 9.2	26.6° ± 10.9	0.603
At final follow-up (1y)	28.4° ± 10.5	29.2° ± 10.9	0.781
p preop vs final follow-up	0.865	0.419	
Lumbar lordosis			
Preop	58.4° ± 16.2	59.6° ± 26.3	0.841
Early postop.	52.5° ± 9.5	52.6° ± 19.2	0.985
At final follow-up (1y)	55.6° ± 16.9	54.7° ± 20.5	0.88
p preop vs final follow-up	0.561	0.478	

* *Statistically significant.*

RESULTS

Demographics

The two groups were not significantly different (Table I, II), as mentioned above. Both groups included one infection, which was treated by debridement and antibiotics, but without removal of the instrumentation.

Radiographic results

Both groups had comparable major curves (62.3° in the wire group, and 63.6° in the tape group) (Table II). Also the preoperative flexibility was comparable (44.6° in the wire group and 41.6° in the tape group). The early postoperative Cobb angle of the major curve was 31.9° in the wire group, and 30.6° in the tape group : the difference was not significant (Table II). In other words, the early postoperative major curve correction was 48.8% in the wire group, and 51.9% in the tape group. At 1 year follow-up the Cobb angle of the major curve was 34.8° in the wire group, and 34.5° in the tape group (difference not significant). In other words, the average correction of the major curve after 1 year was 44.1% in the wire group, and 45.7% in the tape group (difference not significant). The mean preoperative Cobb angle of the minor curve was 41° in the metal wire group and 44° in the tape group. Early postoperative Cobb angle of the minor curve was 21° in the metal wire group, and 24° in the tape group. In other words, the correction averaged 48.8% in the wire group and 45.5% in the tape group. After one year the Cobb angle of the minor curve was 23° in the wire group and 26° in the tape group. In other words, the correction averaged 43.9% in the wire group, and 40.9% in the tape group.

Sagittal correction results are shown in Table II. In the sagittal plane the preoperative thoracic T5T12 angle of 29.1° in the wire group decreased to 25.1%, early postoperatively, while this angle increased from 25.7° to 26.6° in the tape group. After 1 year the T5T12 angle was 28.4° in the wire group, and 29.2° in the tape group. In the wire group the lumbar T12S1 angle decreased from 58.4° preoperatively to 52.5° early postoperatively, and from 59.6° to

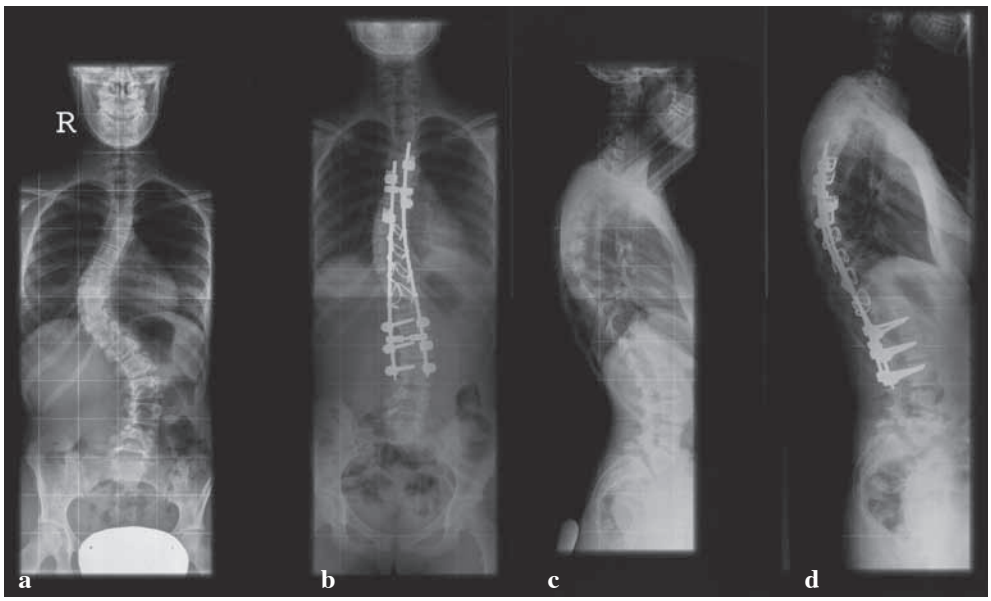

Fig. 1. — **a-d.** Pre- and postoperative frontal and sagittal views showing the results obtained with the classical metal wire technique

52.6° in the tape group. In the wire group the T12S1 angle decreased from 58.4° to 55.6° after one year, and in the tape group from 59.6° to 54.7°.

DISCUSSION

The Universal Clamp is a new implant used in the surgical treatment of spinal deformities. It is made of titanium, thus allowing postoperative MRI imaging, which is necessary in case of syrinx formation, Arnold-Chiari deformity, or certain neurosurgical procedures. The soft polyester tape has less risk of damaging the spinal cord, either during the initial procedure or during removal of the instrumentation. This new implant has a short learning curve for experienced surgeons. Its wider contact surface with the lamina reduces the contact stress and the risk of section of the lamina. Its failure mechanism consists of slippage of the polyester tape through the clamp, which does not lead to neurological damage or fracture of the lamina (*11*). In the authors' experience, there is no considerable difference in operation time or blood loss.

Correction is important, as well in the sagittal plane as in the frontal plane. Spinal deformity surgery should restore trunk height, which is important for pulmonary function, and simultaneously maintain a well-balanced spine, in both frontal and sagittal plane. As Winter *et al* (*16*) pointed out, achieving a well-balanced spine is more important than a few extra degrees in frontal major curve correction.

As to *correction in the frontal plane*, both techniques were able to obtain and to maintain significant correction of the major and minor curves ($p < 0.001$), but there was no significant difference between groups after one year ($p = 0.889$). Many constructs have been described for the frontal correction of scoliosis. Kim *et al* (*8*) concluded that "all screw" constructs achieved better curve correction and maintenance of the correction of the major and secondary curves than "all hook" constructs. However, at least three authors stressed that hybrid constructs are equal to "all screw" constructs. Cheng *et al* (*2*), for instance, pointed out that hybrid constructs with hooks/apical sublaminar wires and lumbar pedicle screws offered the same major curve correction as "all screw" constructs. Also Lowenstein *et al* (*9*) reported that hybrid constructs with thoracic hooks and lumbar pedicle screws led to the same

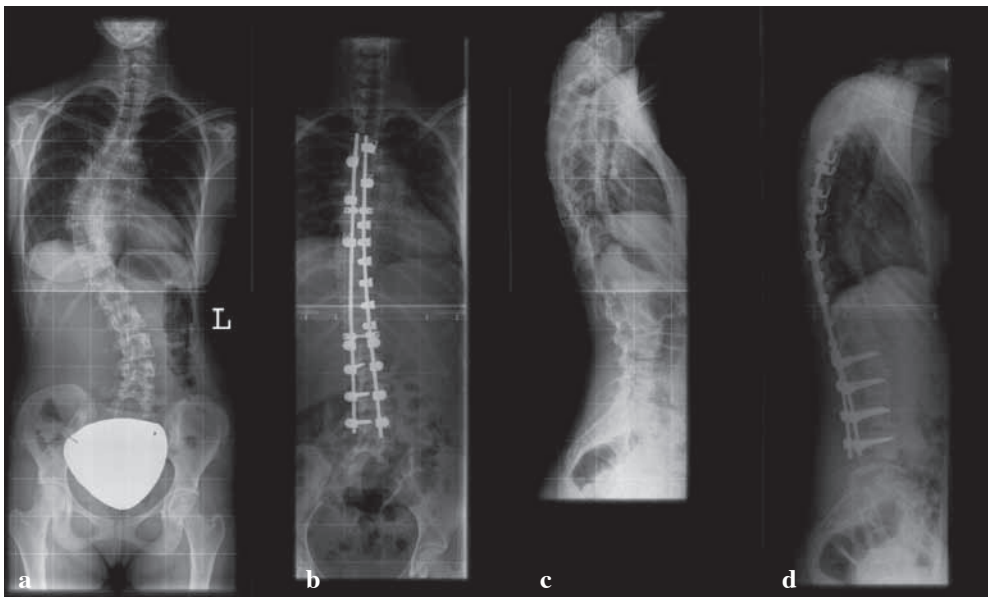

Fig. 2. — **a-d.** Pre- and postoperative frontal and sagittal views showing the results obtained with the more recent polyester tape

major curve corrections as "all screw" constructs. And finally, Vora *et al* (*14*) observed that hybrid constructs yielded major curve correction comparable to the correction obtained with "all screw" constructs. Given the equivalence of "all screw" and hybrid constructs, one might ask which type of hybrid constructs would be preferable. A recent study by Ilharreborde *et al* (*5*) showed that hybrid constructs with thoracic universal clamps, and hybrid constructs with thoracic hooks both achieved significant correction of the major and secondary curves. The current study also stressed the equivalence of two hybrid constructs, as to correction of the major curve.

Axial rotation was not studied. Moens *et al* (*12*) claim that this variable cannot be obtained from standard postoperative radiographs. CT-scans are required, but these were not standard in the follow-up of scoliosis patients.

As to *correction in the sagittal plane* : maintaining sufficient kyphosis in the thoracic spine is important to prevent progression of junctional kyphosis (*7*). According to the literature "all screw" constructs are not able to increase or maintain the thoracic kyphosis, in sharp contrast to hybrid constructs consisting of lumbar pedicle screws and either thoracic hooks or thoracic sublaminar wires. Indeed, both Lowenstein *et al* (*9*) and Vora *et al* (*14*) described a decrease in thoracic kyphosis correction in "all screw" constructs, not seen in hybrid constructs. Thus the authors decided to compare the polyester technique with another hybrid construct which had already proven its effectiveness in maintaining the thoracic kyphosis. They saw an initial decrease of the thoracic kyphosis in the metal wire group, which returned to almost the preoperative value after 1 year : altogether minus 0.7°. However, in the tape group they noted an improvement of the thoracic kyphosis shortly after surgery which even increased one year after surgery : altogether plus 3.5°. There was however no significant difference between groups ($p = 0.781$).

The authors saw a decrease in lumbar lordosis, early postoperatively, in both groups. This decrease was partially maintained one year after surgery : minus 2.8° in the metal wire group, and minus 4.9° in the tape group, but there was no difference between groups ($p = 0.88$). This similarity was to be expected, since hybrid constructs with pedicle screws were used in both groups.

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