LUQUE ROD INSTRUMENTATION IN THE TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS

A COMPARATIVE STUDY WITH HARRINGTON INSTRUMENTATION

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Adolescent idiopathic scoliosis in 152 patients was treated by Luque L-rod instrumentation and early mobilisation without external support. This series was compared with a matched group of 156 patients treated by Harrington instrumentation and immobilised in an underarm jacket for nine months.

All the operations in both groups were performed by one surgeon and the patients were followed prospectively for more than two years. Correction of the scoliosis in the frontal plane was similar in both groups. However, the normal sagittal contour was better maintained with Luque rods, especially in the thoracolumbar and lumbar regions, and provided less loss of correction than with Harrington rods. Neither method significantly derotated the scoliosis. All the patients with Luque instrumentation developed a solid fusion despite breakage of the sublaminar wires at one or two levels in 4.9%. There were no major neurological complications with either type of instrumentation.

Luque L-rod instrumentation with segmental sublaminar wiring has been widely adopted in the treatment of neuromuscular scoliosis because it provides rigid fixation and allows early mobilisation without external support (Luque 1982a,b; Boachie-Adjei et al 1989; Broom, Banta and Renshaw 1989). However, its use in adolescent idiopathic scoliosis remains controversial, and there is concern regarding the surgical risks and long-term effects of passing wires into the spinal canals of patients who have no neurological abnormality (Wilber et al 1984; Thompson et al 1985). In contrast, Harrington instrumentation is a well-established method of treatment for idiopathic scoliosis, and when combined with a posterior fusion sets the standard against which any new method must be compared (Harrington 1962; Goldstein 1969; Harrington and Dickson 1973; Leider, Moe and Winter 1973; Erwin, Dickson and Harrington 1976; Livallo, Banta and Renshaw 1986). Any new technique must therefore provide better correction of the deformity, maintain spinal balance, produce a solid fusion and, most importantly, achieve these results with few complications.

The purpose of this paper is to compare the performance of Luque L-rod instrumentation, using segmental sublaminar wiring, with Harrington instrumentation in two matched groups of patients with adolescent idiopathic scoliosis undergoing posterior spinal fusion.

MATERIAL AND METHODS

Between 1975 and 1987, 308 patients with adolescent idiopathic scoliosis, all under the age of 19 years, were treated surgically at the Princess Margaret Rose Orthopaedic Hospital by means of posterior spinal fusion and instrumentation. These patients were studied prospectively and fell into two consecutive groups depending on the method of surgical instrumentation used to correct and stabilise the deformity. All the operations were performed by the author providing a uniform technical proficiency.

One group consisted of 152 patients treated between 1983 and 1987 by Luque L-rod instrumentation with segmental sublaminar wiring followed by early mobilisation without external support. The other group of 156 patients treated was between 1975 and 1983 by Harrington instrumentation followed by nine months in an underarm plaster jacket. The groups were well matched for age and sex and for the site and severity of the scoliosis.

All patients were followed for more than two years after the operation. The indications for surgical treatment were a patient over the age of 11 years with a scoliosis of

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more than 50° when first seen or a curve of more than 40° which was deteriorating.

Luque group. In this group there were 123 girls and 29 boys; their mean age at operation was 14 years seven months (range 11 years seven months to 18 years seven months). There was a single structural curve in 130 cases of which 105 were thoracic and 25 thoracolumbar. There were 22 patients with double structural scolioses; 20 were in the thoracic and lumbar regions, and two were double thoracic curves. The mean curvature, before operation, was 57° (range 40° to 115°). The mean follow-up time was three years two months (range two to six years).

All the operations were performed in the same way. The spine was exposed through a midline posterior incision and the muscles stripped subperiosteally to the tips of the transverse processes on both sides. The scoliosis was corrected by applying two pre-bent (4.76 mm diameter) stainless steel rods, one on either side of the spinous processes, throughout the length of the deformity. The two rods were bent intra-operatively to conform not only to the estimated degree of correction of the scoliosis, but also to create or maintain the normal thoracic kyphosis and lumbar lordosis, as well as to derotate the spine. The rods, which were L-shaped at one end to prevent migration up and down the spine, were fixed to each vertebra by means of 16-gauge (1.22 mm) stainless steel wires passed beneath the laminae and twisted on top of the rod. Double wires were used on both sides to fix the rods at their upper and lower ends. Passage of the wires required a midline laminotomy and excision of the ligamentum flavum at each vertebral level. The convexly curved rod was applied first and used to lever the spine straight by progressively wiring it to each of the vertebrae within the curve, starting from the upper neutral vertebra and proceeding to the lower neutral vertebra. Intra-operative spinal cord monitoring of somatosensory evoked potentials with an epidural electrode was used routinely from 1986.

A posterior spine fusion was performed throughout the instrumented area, but with some modifications compared to the Harrington group. The laminae were not decorticated because this could weaken the bone and cause the wires to cut through. The facet joints were excised bilaterally prior to the application of the spinal instrumentation, and once the spine was corrected they were packed with autogenous iliac bone grafts. More iliac bone, cut into matchsticks, was laid in both paraspinal gutters lateral to the Luque rods and overlying the excised facet joints and the decorticated transverse processes.

On the fourth day after surgery, patients were allowed to walk without any form of external support. They returned to school within two to three weeks and were allowed to swim after three months. They were told to avoid all rough sports for nine months.

Harrington group. In this group there were 123 girls and 33 boys. Their mean age at operation was 14 years six

months (range 11 years two months to 18 years ten months). There was a single structural curve in 128 cases of which 117 were thoracic and 11 were thoracolumbar. There were 28 patients with a double structural scoliosis of which 23 were in the thoracic and lumbar regions and five were double thoracic curves. The mean curvature before surgery was 60° (range 40° to 122°). The mean follow-up time was three years six months (range two years two months to seven years eight months).

The spine was exposed in the same manner as in the Luque group, but in these patients the scoliosis was corrected by applying a single Harrington distraction rod across the concavity between the neutral vertebrae at either end of the curve (Harrington 1962). In a double scoliosis the single rod spanned both curves. A posterior facet joint fusion was performed bilaterally in the same manner as in the Luque group, but in addition the laminae and transverse processes were deeply decorticated before the application of the iliac bone grafts (Moe 1958; McMaster 1980).

One week after surgery, a well moulded underarm plaster jacket was applied and the patient was allowed to walk. The jacket was worn for nine months, after which the patient was allowed unrestricted activities without external support.

Prophylactic antibiotics were given to both groups of patients commencing immediately before surgery, and continuing for 24 hours postoperatively.

RESULTS

The severities of the scoliosis, thoracic kyphosis and lumbar lordosis were measured, using the Cobb method, on anteroposterior and lateral spinal radiographs taken with the patient standing, before and after surgery, and then every six to nine months until the final assessment. The loss of correction was the difference between the angle measured on the immediate postoperative radiograph and that measured at the last examination.

Rotation of vertebrae was difficult to measure on the postoperative anteroposterior radiographs because the overlying rods obscured the concave margin of the vertebral body which is normally used as a reference point (Nash and Moe 1969; Pedriolle 1979). This problem was overcome by measuring the distance between the convex border of the apical vertebral body and the medial border of the pedicle on the same side, and comparing this with the width of the lower neutral vertebra at its mid-point. The lateral margins of the neutral vertebrae were not obscured by the rods and this ratio was used to estimate any change in the degree of rotation of the apical vertebra. Its use also overcame the problem of different magnifications of the serial radiographs.

For the purposes of analysis, both groups were divided into those with a single thoracic, single thoracolumbar, double (thoracic and lumbar) and double thoracic curves. Each curve type was subdivided into four, those

with curves from 40° to 49° from 50° to 59°, from 60° to 69° and those with curves of more than 70°. These subgroups were compared for differences between Luque and Harrington instrumentation regarding the angle of curve after correction, percentage correction and loss of correction.

This data, which is summarised in Tables I and II, was subjected to statistical analysis using standard *t*-tests and analysis of variance.

Single thoracic curves. Of the 222 single thoracic curves, 105 were treated by Luque L-rod instrumentation and 117 by Harrington instrumentation. A mean 10.5 vertebrae (range 9 to 13) per patient were instrumented in the

Luque group and 10.6 vertebrae (range 8 to 13) per patient in the Harrington group.

The pre-operative mean curve was 56° (range 40° to 107°) in those treated by Luque instrumentation and 61° (range 40° to 122°) in those who had Harrington instrumentation ($p = 0.03$). After surgery the mean curve in the Luque group was reduced to 25° (range 5° to 53°), a 56% mean correction (Figs 1a,b). In the Harrington group the mean curve after surgery was 28°, a 55% mean correction. There was no significant difference in the degree of correction obtained in the different sizes of curve nor between the two methods of instrumentation (Tables I and II).

Table I. Details of 152 patients with adolescent idiopathic scoliosis treated by Luque rod instrumentation

Type and curve severity*	Number	Mean age (yr mth)	Number of vertebrae fused	Mean curve*		Correction (per cent)	Mean loss of correction*
				Pre-operative	Postoperative		
Thoracic							
40 to 49	39	14 5	10.3	44	18	59	1.8
50 to 59	31	14 7	10.5	54	24	56	1.7
60 to 69	18	15 4	10.5	64	30	53	2.6
> 70	17	13 9	11.2	81	36	56	1.9
Thoracolumbar							
40 to 49	16	15 6	10.6	44	14	69	2.4
50 to 59	3	15 9	11	50	16	69	2.7
60 to 69	3	15	10.3	63	28	55	2.3
> 70	3	16	11.3	92	44	53	4.3
Double; thoracic and lumbar							
40 to 49	6	15	13.3	45:47	25:20	44:57	2:4.8
50 to 59	2	14 7	13	54:56	33:26	40:54	1:2
60 to 69	4	15 5	13	60:60	35:24	42:60	1.5:5.5
> 70	8	14 5	13.5	76:73	42:32	45:56	3:5
Double; thoracic	2	13 9	13	40:56	30:27	25:52	2:2

*measurement in degrees

Table II. Details of 156 patients with adolescent idiopathic scoliosis treated by Harrington instrumentation

Type and curve severity*	Number	Mean age (yr mth)	Number of vertebrae fused	Mean curve*		Correction (per cent)	Mean loss of correction*
				Pre-operative	Postoperative		
Thoracic							
40 to 49	36	14 1	10	43	19	57	4.5
50 to 59	24	14 5	10	54	23	58	5.4
60 to 69	22	15 2	10.5	64	30	54	5.3
> 70	35	14 10	10.5	83	39	53	5.5
Thoracolumbar							
40 to 49	5	15 3	10.5	43	16	61	9.5
50 to 59	3	15	11.5	55	18	64	10
60 to 69	1	18	13	61	20	67	10
> 70	2	15 7	9	79	36	55	13
Double; thoracic and lumbar							
40 to 49	4	14 3	11	43:42	21:16	51:62	8:9
50 to 59	8	13 6	12.75	54:46	26:18	52:61	8:8
60 to 69	3	14 5	12.3	60:63	32:31	47:51	5:9
> 70	8	15	13.1	74:75	43:37	42:51	9:10
Double; thoracic							
50 to 59	3	13 7	13	50:59	26:25	48:58	9:10
60 to 69	2	14 6	13	47:64	32:36	32:44	5:9

*measurement in degrees

Figure 1a – A girl aged 14 years six months with a 61° adolescent idiopathic thoracic scoliosis; b) three years after Luque L-rod instrumentation and posterior fusion from T4 to L1, the curve remains well corrected at 28° and there is solid fusion; c and d) the pre-operative thoracic lordosis of 13° has been corrected to a 21° kyphosis.

The mean loss of correction in thoracic curves treated by Luque instrumentation was 1.9°, significantly less than the mean 5.1° lost in those treated by Harrington instrumentation ($p < 0.001$). In both treatment groups loss of correction was independent of the pre-operative size of the curve ($p = 0.74$, $p = 0.43$; Tables I and II).

The Luque rods were bent differentially in an attempt to derotate the vertebrae and also to maintain or restore the normal thoracic kyphosis. Despite this technique there was no significant change in the degree of vertebral rotation after surgery. However, the thoracic kyphosis which measured a mean 24° (range -9° to 58°) over the instrumented area before surgery was increased following Luque instrumentation by more than 5° in 28 patients (Figs 1c,d), remained unchanged in 56 and was decreased by more than 5° in 21 patients. If the kyphosis was less than 20° pre-operatively there was a tendency for it to increase (25 of the 35 patients) whereas in the 21 patients with a pre-operative kyphosis greater than 30°, 12 decreased and the remainder were unchanged.

Harrington instrumentation had no effect on derotating the spine and also caused a flattening of the thoracic kyphosis in all the patients. Before surgery the mean thoracic kyphosis over the instrumented area was 26° (range -7° to 48°) and this was significantly reduced to a mean 12° (range 10° to 28°) after surgery.

Thoracolumbar curves. Of the 36 thoracolumbar curves, 25 were treated by Luque L-rods and 11 by Harrington rods. A mean of 10.7 vertebrae (range 8 to 13) per patient were instrumented in the Luque group and 10.4 vertebrae (range 9 to 13) per patient in the Harrington group. The lower ends of the Luque rods extended to L3 in four

patients, L4 in 15 and L5 in six; the Harrington rods extended to L4 in all 11 patients.

The pre-operative mean curve was 53° (range 40° to 115°) in those treated by Luque instrumentation and was 53° (range 40° to 83°) in those with Harrington instrumentation. After surgery, the mean curve in the Luque group was reduced to 19° (range 3° to 60°), a 65% mean correction (Figs 2a,b). The degree of correction was similar with the Harrington instrumentation; the mean curve was reduced to 20°, a 62% correction ($p = 0.46$). However, with the Luque, but not with the Harrington instrumentation, there was significantly greater correction of curves of less than 60° compared to those of greater angle (Tables I and II).

The mean loss of correction for thoracolumbar curves treated by Luque instrumentation was 2.7°; this ranged from 2.4° for pre-operative curves of less than 50° to 4.3° for curves of over 70°. In the Harrington group the mean loss of correction ranged from 9.5°, for curves of 40° to 49°, to 13° for curves of more than 70°. The mean loss (10.1°) was significantly greater than in the group treated with Luque rods ($p = 0.0003$).

The pre-bent Luque rods were successful in maintaining or restoring the lumbar lordosis in all 25 patients (Figs 2c,d). Before surgery the mean lumbar lordosis over the instrumented area was 18° (range 15° kyphosis to 36° lordosis) and following Luque instrumentation this was improved to a mean 21° (range 2° to 48°). However, rotation of the spine was improved in only 15 patients and remained unchanged in ten.

Harrington instrumentation had no effect on rotation and caused flattening of the lumbar lordosis in all the

Fig. 2a

Fig. 2b

Fig. 2c

Fig. 2d

Figure 2a – A girl aged 15 years one month with a 48° adolescent idiopathic thoracolumbar scoliosis; b) two years and ten months after Luque L-rod instrumentation and posterior fusion from T7 to L4, the curve remains well corrected at 8° and there is solid fusion; c and d) The pre-operative lumbar lordosis has been well maintained.

patients. Before surgery the mean lumbar lordosis over the instrumented area was 20° (range 7° kyphosis to 35° lordosis) and this was significantly reduced to 8° (range 8° kyphosis to 14° lordosis) after surgery.

Double curves, thoracic and lumbar. Of the 43 double structural curves in the thoracic and lumbar regions, 20 were treated with Luque rods and 23 with Harrington rods. A mean 13.3 vertebrae (range 12 to 15) per patient were instrumented in the Luque group and 12.6 vertebrae (range 11 to 15) per patient in the Harrington group ($p = 0.025$). The lower ends of the Luque rods extended to L4 in 19 patients and to L5 in one; the Harrington rods extended to L3 in two patients, to L4 in 15 and to L5 in six patients (Tables I and II).

The pre-operative mean thoracic and lumbar curves were 61° and 62° respectively in the Luque group and 60° and 58° in the Harrington group.

The effect of Luque instrumentation was different for each of the two curves (Figs 3a,b). The thoracic curves corrected in the same way as did the single thoracic scolioses; there was a 43% correction in the frontal plane, no change in rotation and in only ten curves (50%) was there improvement by more than 5° in the sagittal plane. The lumbar curves corrected in the same manner as did the single thoracolumbar scolioses; there was a mean 56% correction in the frontal plane and the lumbar lordosis was maintained in all the patients, but only 40% had an improvement in rotation.

With Harrington instrumentation, the mean correction of the thoracic and lumbar curves in the frontal plane was 47% and 56% respectively, not significantly

Fig. 3a

Fig. 3b

Figure 3a – A girl aged 15 years with a double structural adolescent idiopathic scoliosis; b) two years six months after surgery good correction has been maintained and there is a solid fusion.

different from the correction obtained by Luque instrumentation. However, the main disadvantage of Harrington rods was significant flattening both of the thoracic kyphosis and the lumbar lordosis, so that the spine became one straight column in the sagittal plane over

the instrumented area. Vertebral rotation remained unchanged.

The mean loss of correction for the thoracic and lumbar curves treated by Luque rods was 2.2° and 4.7° respectively. In the Harrington group the mean loss of correction, 8° and 9.3° was significantly greater.

Double thoracic curves. Of the seven patients with double structural thoracic curves, two were treated with Luque rods and five with Harrington rods (Tables I and II). There were too few for significant comparison.

Operative time and blood loss. The mean duration of the operations on patients treated with Luque rods was 195 minutes (range 165 to 225); and in the Harrington group, 180 minutes (range 120 to 240). The mean total blood loss, during and after the operation, in the Luque group was 1490 ml (range 695 to 2945) and in the Harrington group, 1200 ml (range 500 to 2458).

Duration of hospital stay. The mean time spent in hospital for the Luque treated patients was 13 days (range 11 to 21), significantly less than the 19 days (range 11 to 45) required for the Harrington group.

COMPLICATIONS

Neurological. There were no major neurological complications as a result of either method of instrumentation. However, four patients treated with Harrington rods (2.5%) and one patient treated with Luque rods (0.6%) complained of mild paraesthesia affecting the soles of the feet; the patients with Harrington instrumentation had curves which had all been corrected by more than 60% whereas the one patient with Luque instrumentation had only 45% correction. There were no objective neurological abnormalities and the paraesthesia resolved completely within 24 to 48 hours in all five patients. A further two patients treated with Luque rods (1.3%) complained of mild paraesthesia extending in a radicular manner around one side of the trunk; this also recovered completely within a few months.

A mild brachial plexus palsy occurred in two patients; one with Luque and one with Harrington instrumentation. Both patients were noted to have paraesthesia and slight weakness of one hand which was thought to be due to stretching of the lower roots of the brachial plexus caused by hyperabduction of the arm during the operation. Both recovered normal power and sensation within a few months.

Paraesthesia in the distribution of the lateral cutaneous nerve of the thigh occurred in two patients with Harrington instrumentation. This was thought to be due to pressure on the nerve by the plaster jacket and recovered once the plaster was trimmed.

Wound healing. One patient who had Luque instrumentation had a major wound infection. This presented several weeks after the operation as a discharging sinus in the upper part of the wound and did not heal with antibiotics. Five months later the sinus was explored and

found to extend to the fusion mass which was noted to be solid with no pseudarthroses. The sinus was completely excised and the Luque rods and sublaminar wires were removed. The wound then healed and when last seen, 40 months later, there was only a 2° loss of correction. There were no major infections in the patients with Harrington instrumentation, but two developed superficial infections of the iliac crest wounds which responded rapidly to local care and antibiotics.

Minor wound dehiscence, which required resuture, occurred in two patients in each treatment group.

Haematomas occurred in 13 patients with Luque instrumentation (8%), two in spinal wounds and 11 in iliac crest wounds. They were thought to be due to the very early mobilisation of these patients and did not occur so frequently in patients who were kept in bed for four days after operation. Eight patients with Harrington instrumentation (5%) developed haematomas, three in spinal wounds and five in iliac crest wounds.

Failure of instrumentation. None of the Luque rods fractured, but the sublaminar wires broke at one or two levels in seven patients (4.6%). There was a total of ten broken wires out of the 3330 sublaminar wires employed (0.3%). The wires broke at the lower two instrumented levels in seven patients and also at the uppermost level in two. However, none of these patients had any related symptoms or neurological complications; all developed a solid fusion, and in only one was there a significant loss of correction. This patient had a 42° thoracolumbar curve which was corrected to 7°. Within the first three months the wires broke at the lower level where they secured the junction of the L-rod and the straight rod, allowing the rods to rotate so that the lordotic curve which had been pre-bent into the rods became a scoliotic curve. The deformity relapsed to 22°. This patient, who has been followed for 29 months, has had no further loss of correction. Surgery was never necessary to remove the broken wires in any of the patients.

One patient with Harrington instrumentation was found to have a broken rod at radiographic review three years seven months after operation. She had lost 10° of correction, but there was a solid fusion and no treatment was thought necessary. Six years later there was no further loss of correction. Two patients with double thoracic scolioses treated with Harrington rods dislocated the upper hooks at the T1 level within a week of operation. Both required a second operation to re-insert the hooks, which were then stabilised with methylmethacrylate cement.

Pseudarthrosis. There were no pseudarthroses in the patients with Luque instrumentation. One patient with Harrington rods (0.6%) developed a pseudarthrosis. This was a 13-year-old girl with a thoracolumbar scoliosis which had been corrected from 45° to 8°. Six months after operation there was a 9° loss of correction, and a pseudarthrosis was diagnosed radiographically at the thoracolumbar junction. The pseudarthrosis was repaired

and a plaster jacket applied for five months, after which the spine became solidly fused. The patient has been followed for three years, and there has been no further loss of correction.

DISCUSSION

This study and others have shown that Harrington rods are an effective means of achieving correction of idiopathic scoliosis in the frontal plane (Harrington and Dickson 1973; Leider, Moe and Winter 1973; Erwin, Dickson and Harrington 1976; Tolo and Gillespie 1981; Lovallo et al 1986), but that the method does not derotate the spine and that it produces flattening of the normal sagittal contour (Casey et al 1987; Luk et al 1987). Cochran, Irstam and Nachemsom (1983) found that if the instrumentation extended to the lower lumbar region, the reduction in lordosis could increase the stress on the unfused distal segments and predispose to backache and degenerative changes in later life. On occasion there may be an excessive flattening of the lumbosacral spine resulting in the 'flat back' syndrome in which the patient is tilted forwards and only able to stand erect by flexing the knees (LaGrone et al 1988). The ideal form of instrumentation should not only correct the lateral curve, but should maintain or restore the normal thoracic kyphosis and lumbar lordosis as well as derotating the spine.

In this study Luque L-rod instrumentation and Harrington instrumentation were found to be equally effective in correcting the frontal plane deformity regardless of the site or degree of the curve. However, Luque instrumentation was significantly more effective in maintaining correction. A further advantage was that the contoured Luque rods were much more effective in preserving the normal sagittal profile of the spine, especially in the thoracolumbar and lumbar regions. The major defect of the Luque system was that it had no effect on derotating the vertebrae in the thoracic region, and had only a moderate effect in the thoracolumbar and lumbar regions.

The relative failure of Luque instrumentation to simultaneously derotate as well as correct the spine in the frontal and sagittal planes may be explained by the three-dimensional nature of the original deformity. In idiopathic thoracic scoliosis there is a short segment lordosis at the apex of the curve and the axis of rotation lies posterior to these vertebrae (Dickson et al 1984). It is therefore only possible to simultaneously derotate and restore the normal kyphosis by pulling the concave side of the vertebrae directly backwards towards this axis. Luque instrumentation is ineffective because the convex rod, which is pre-bent to restore the thoracic kyphosis, is applied first and used to lever the spine straight (in the frontal plane) by wiring it to each of the vertebrae within the curve. Although this may maintain the thoracic kyphosis, it cannot derotate the spine. Once the convex

rod is in position the spine is fixed, and it is not possible to use the concave rod to pull the concave side of the spine backwards, and so derotate the vertebrae. However, in the thoracolumbar and lumbar regions, the Luque rods are more effective in correcting the deformity in all three planes. The convex rod which is used to straighten the spine in the frontal plane is pre-bent anteriorly to maintain or create the normal lumbar lordosis, and as this rod is levered into position it pushes the convexity of the spine forward, and so effects a degree of vertebral rotation as well as preserving the lumbar lordosis.

The risk of neurological complications following Harrington instrumentation in adolescent idiopathic scoliosis is approximately 0.5% (MacEwan, Bunnell and Sriram 1975). With Luque rods there is an added risk due to the passage of the wires into the spinal canal, and there is a significant learning curve. The incidence of neurological complications following Luque instrumentation in adolescent idiopathic scoliosis has been reported to be as high as 17%, with major cord injury occurring in 4% (Herring and Wenger 1982; Moore and Eilert 1983; Wilber et al 1984; Thompson et al 1985). An American Scoliosis Research Society survey (Morbidity and Mortality Committee Report 1987) found a four times greater risk of spinal cord injury following sublamina wiring than with standard Harrington instrumentation. Bunch and Chapman (1985) found that patients about to undergo spinal surgery were most concerned by the risk of neurological complications, followed by the fear of having to have a second operation. They were less concerned about the need to wear a brace or cast, and about the amount of correction obtained. In these circumstances, it is debatable whether the advantages of Luque rods outweigh their possible risks. However, in this series, all the sublamina wires were passed by one experienced surgeon and there were no serious neurological complications.

It was necessary to remove the Luque rods and wires in one patient six months after surgery because of a major wound infection. Fortunately, this too was performed without neurological complications, but removing multiple sublamina wires embedded in bone is riskier than removing Harrington rods and hooks and this is a major disadvantage of the Luque technique.

An advantage of the Luque system over Harrington rods is that it provides fixation at each level so that loss of fixation at one level, due to bone failure or wire breakage, does not necessarily compromise the whole system. No further operations were necessary in the seven patients in whom sublamina wires broke, whereas two patients with Harrington instrumentation required further surgery to relocate dislocated hooks.

The long-term success of the surgery of spinal deformity depends not on the instrumentation, but on the achievement of a solid spinal fusion. If a pseudarthrosis develops, any form of implant will ultimately fail and correction will be lost. It has been shown that a solid

fusion is more likely to occur following meticulous bilateral interfacet and intertransverse fusion, followed by decortication of the laminae and the onlay of large amounts of autogenous iliac bone grafts (Moe 1958; Goldstein 1969; Erwin et al 1976; McMaster 1980). With Luque instrumentation the area of bone available for fusion is much smaller than with Harrington instrumentation, and it is not safe to decorticate the laminae because it weakens the fixation. However, none of the patients in this series with Luque instrumentation was thought to have developed a pseudarthrosis, although the radiographic diagnosis is not easy when the fusion mass is obscured by an overlying metal implant. Furthermore, the very rigid fixation provided by Luque rods may prevent loss of correction, which is often the only indication of a pseudarthrosis. Though all the patients were followed for more than two years, it is still possible for a pseudarthrosis to manifest itself later by the development of a fractured rod.

In conclusion, Luque rod instrumentation with segmental sublaminar wiring is a more difficult and potentially dangerous procedure. However, with care and experience, good results can be achieved with few complications, though the long-term effect of wires within the spinal canal remains unknown. The main advantages of Luque rods are that they maintain the normal sagittal contour, especially in the thoracolumbar and lumbar regions, and prevent loss of correction better than Harrington rods. The greater rigidity provided by segmental sublaminar wiring allows the patient to be mobilised within a few days of operation without external support. The main disadvantage of the method is that it has very little effect on derotating the spine, especially in the thoracic region.

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