DWYER INSTRUMENTATION IN THE TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS

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Twenty-eight patients with adolescent idiopathic scoliosis treated by anterior spinal fusion with Dwyer instrumentation were reviewed. The average length of follow-up was 6.9 years. This technique produced better correction of lateral curvature and rotation than Harrington instrumentation, particularly in the thoracolumbar and lumbar region. The length of spine requiring fusion was also shorter. There is, however, a tendency for Dwyer instrumentation to lead to kyphosis. Morbidity was significant and included one case of paraplegia, four cases of deep infection and one case of instrument failure. All of these complications, except one case of deep infection, occurred in patients with curves with an apex above the seventh thoracic vertebra.

In 1964 Dwyer and Newton began using cable and screw instrumentation designed by Sherwood for the management of scoliosis (Dwyer, Newton and Sherwood 1969). In 1974 Dwyer and Schafer reported their experience with 51 cases of scoliosis treated using this technique; 16 of these cases were of adolescent idiopathic scoliosis. Since then several authors have discussed the indications for using the technique (Hall 1972, 1981; Simmons et al. 1977; Stephens, Wilding and Cass 1977; Moe et al. 1978; Bradford 1979). Most authors accept the use of Dwyer instrumentation in paralytic scoliosis but its place in the management of adolescent idiopathic scoliosis remains to be defined. The paucity of documented cases with sufficient follow-up has prompted us to report our experience with Dwyer instrumentation in the management of adolescent idiopathic scoliosis.

MATERIAL AND METHODS

All patients with adolescent idiopathic scoliosis treated by anterior spinal fusion with Dwyer instrumentation at the Duchess of Kent Children's Orthopaedic Hospital, Hong Kong, with a minimal follow-up of two years were reviewed. There were 28 patients, 24 females and four males. The average age at operation was 15.3 years with a range of 13 to 19 years. The average length of follow-up was 6.9 years; range 2 to 13 years.

Four patients were excluded from the general review. They had thoracic curves with an apex above the seventh thoracic vertebra and had been among the first we treated in this way when we were unfamiliar with the indications for instrumentation. They all had very poor correction (Table I) and significant complications.

Seven of the remaining 24 patients had thoracic curves whose apex was below the seventh thoracic vertebra (low thoracic curves), 13 had thoracolumbar curves and four had lumbar curves. The extent of curvature was determined from radiographs taken with the patient standing, using the Cobb method of measurement (Table I).

Using lateral radiographs taken with the patient standing, assessment was made of the kyphosis over the instrumented segment of the spine at follow-up by drawing lines along one of the end plates of the two end vertebrae of the curve. As when measuring the degree of scoliosis, perpendiculares to these lines were drawn and the angle formed by their intersection was taken as the amount of kyphosis. The amount of kyphosis was not assessed before operation.

We used the grading system of Nash and Moe (1969) to assess rotation of the vertebral bodies before and after operation. The rotation of each vertebra in the major curve was graded on the radiograph from 0 to 4. The sum of the grades of rotation divided by the number of vertebrae in the curve gave the average grade of rotation per vertebra—the rotation score. For comparison, 20 randomly selected patients with idiopathic adolescent scoliosis who had undergone posterior spinal fusion with Harrington instrumentation were similarly measured before and after operation. These 20 control patients

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Table I. Details of the degree of curvature before and after operation and the amount of kyphosis at follow-up (shown as average figures and range)

<table>
<thead>
<tr>
<th>Type of curve</th>
<th>Number of patients</th>
<th>Curvature before operation (degrees)</th>
<th>Curvature at follow-up (degrees)</th>
<th>Correction at follow-up (degrees)</th>
<th>Residual kyphosis at follow-up (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic curves with an apex above T7</td>
<td>4</td>
<td>71 (45 to 97)</td>
<td>76 (42 to 125)</td>
<td>-5 (-28 to 3)</td>
<td>-</td>
</tr>
<tr>
<td>Thoracic curves with an apex below T7</td>
<td>7</td>
<td>61 (47 to 67)</td>
<td>26 (8 to 40)</td>
<td>35 (24 to 50)</td>
<td>40 (24 to 66)</td>
</tr>
<tr>
<td>Thoracolumbar curves</td>
<td>13</td>
<td>51 (42 to 78)</td>
<td>14 (-8 to 28)</td>
<td>37 (15 to 60)</td>
<td>26 (5 to 48)</td>
</tr>
<tr>
<td>Lumbar curves</td>
<td>4</td>
<td>57 (48 to 80)</td>
<td>17 (7 to 26)</td>
<td>40 (18 to 45)</td>
<td>18 (7 to 30)</td>
</tr>
<tr>
<td>All curves apexed below T7</td>
<td>24</td>
<td>55 (42 to 80)</td>
<td>18 (-8 to 40)</td>
<td>37 (15 to 60)</td>
<td>-</td>
</tr>
</tbody>
</table>

Each had a single major curve—12 thoracic, six thoracolumbar and two lumbar.

Indications for operation were progression of the curve despite bracing, curves greater than 40 degrees, or both. The operative technique described by Dwyer was used with particular emphasis on complete excision of the disc, annulus and end plates back to the posterior longitudinal ligament (Dwyer 1973; Dwyer et al. 1969). The average length of the operation was 3.8 hours (range 2.5 to 5.5 hours) and the average blood loss was 1645 millilitres (range 440 to 3400 millilitres). The patients were kept in a Stryker frame for two weeks after the operation and then immobilised in a plaster body-jacket for an average of 21 weeks (range 16 to 27 weeks).

RESULTS

Table I gives the average degree of curvature of the various types of major curves before and after the operation and the amount of kyphosis at follow-up. The overall correction for the 24 patients ranged from 15 to 60 degrees with an average of 37 degrees (67 per cent). The thoracolumbar and lumbar curves had better correction, 73 per cent and 70 per cent respectively, compared to 57 per cent correction for low thoracic curves.

The minor curves ranged from 20 to 62 degrees with an average of 38 degrees before operation. The average correction was 19 degrees (50 per cent) with a range of 5 to 33 degrees. They were never included in the instrumentation. None of these minor curves had more than five degrees of deterioration one year after the operation.

Table II shows the amount of correction of rotation determined by the method already described. The average score for rotation after operation was 1.48, an improvement of 0.86 (37 per cent). This compares favourably to the decrease in rotation from 2.42 to 2.04 in the 20 patients who had posterior spinal fusion with Harrington instrumentation, an improvement in rotation of 0.38 (16 per cent).

The number of vertebrae fused per patient ranged from 3 to 7 with an average of 4.7. If the same curves had been treated with Harrington instrumentation, the number of vertebrae fused would have ranged from 6 to 10 with an average of 7.8, an average increase per patient of 3.1 vertebrae.

COMPLICATIONS

The four patients with thoracic curves above the seventh thoracic vertebra all had poor correction and major complications. One of these patients, a 16-year-old boy with a 96-degree curve, had a screw inserted into the spinal canal which resulted in paraplegia. A laminectomy was done eight hours after the initial operation and part of the instrumentation was removed; he did not recover from his paralysis. A chronic deep wound infection subsequently developed and was drained intermittently until the remaining hardware was removed eight years later.

A second patient, a 17-year-old girl, had a 97-degree curve corrected to 66 degrees but soon after the operation one screw fractured and the cable pulled out of the lower screws. She subsequently developed frank pseudarthrosis and the curve deteriorated to 125 degrees.

The remaining two patients, aged 13 and 15 years, had curves of 45 and 48 degrees. Both of them had only three degrees of correction after anterior fusion and both developed deep infections which were initially supressed with antibiotics. They subsequently had chronic infections with paravertebral abscesses and discharging sinuses and required debridement and removal of the instrumentation.
One of the remaining 24 patients developed a deep infection with a discharging sinus one year after operation. The infection subsided after removal of the instrumentation. In another patient the deformity was thought to have increased below the area of instrumentation and she had a posterior fusion one year after anterior fusion. In retrospect, it was felt that this was unnecessary.

Significant loss of correction of more than five degrees occurred in two patients within one year of the operation. Both patients lost 12 degrees of correction for which there was no obvious cause.

There were no cases of pseudarthrosis. Three patients had doubtful solid union at one level after removal of the plaster jacket but went on to solid union at one year without further immobilisation. There was no associated loss of correction.

The thoracolumbar curves of two patients had been
overcorrected resulting in the reversal of the major curve. One of these patients had 19 degrees of over-correction immediately after the operation but lost 11 degrees during the first year and was only overcorrected by eight degrees at follow-up. The other curve was originally overcorrected by 11 degrees but this decreased to six degrees at follow-up. The scoliosis in both these patients was cosmetically insignificant.

DISCUSSION

Dwyer instrumentation has not been a popular method of treatment of idiopathic scoliosis which probably accounts for the paucity of documented cases in the literature. Some of the reasons given for this unpopularity are based on the high rates of pseudarthrosis reported in early series and the difficulty of the procedure compared with the more familiar posterior approach (Hall, Gray and Allen 1977; Hall 1981). The procedure also tends to shorten the anterior part of the spinal column and therefore to produce kyphosis. Its complications, such as deep infection and retroperitoneal fibrosis with ureteric obstruction, are formidable and often difficult to detect and manage (McMaster and Silber 1975; Dwyer et al. 1976, 1977; Hall 1981).

In our experience, instrumenting an upper thoracic curve is certainly a difficult procedure; Dwyer has alluded to these difficulties (Dwyer 1979). Inadequate bone stock, greater rigidity and problems with exposure makes the procedure hazardous and ineffective for the thoracic spine. It offers no advantage over the traditional approach, and should perhaps be condemned.

Our experience has shown that there is possibly a place for the Dwyer instrumentation for correcting thoracolumbar or lumbar curves (Figs 1 to 7). As shown in our series, correction of the scoliosis is good, with 73 per cent correction for thoracolumbar curves and 70 per cent correction for lumbar curves. The fusion area is short, averaging only 4.5 vertebrae for the thoracolumbar curves and 4.2 vertebrae for lumbar curves. In this region, a shorter length of spinal fusion with more complete correction of curvature allows the segments below the instrumentation to be more mobile and to share the stresses. This is an important advantage. The other advantage is that it is effective in rotational correction of the spine; based on the method of determining rotation devised by Nash and Moe (1969), Dwyer instrumentation is, on average, approximately twice as effective as Harrington instrumentation in derotating the spine. The average rotational correction for Dwyer instrumentation in our 24 cases was 37 per cent compared with 16 per cent for Harrington instrumentation. With thoracolumbar curves the difference is even greater (Table II).

In the lower thoracic spine, in our limited experience with only seven cases, we are uncertain as to whether this technique offers any significant advantage over the standard Harrington technique. The amount of scoliosis correction of 57 per cent is only slightly better than correction figures of 40 to 50 per cent for many published series using Harrington instrumentation (Dickson and Harrington 1973; Lau et al. 1981). However, correction of rotation is more effective with anterior fusion resulting in better correction of the rib hump (Fig. 8 to 16). In the lower thoracic region a shorter area of fusion, an advantage of the Dwyer technique, is less important when compared with the thoracolumbar or the lumbar spine. Because of its tendency to lead to kyphosis, it is said that the use of Dwyer instrumentation should be reserved in the lower thoracic spine for those cases associated with lordosis, as correction of the latter may improve pulmonary function (Winter, Lovell and Moe 1975; Hall 1981).

One of the disadvantages of using Dwyer instrumentation is the obligatory increase in, or production of,
kyphosis. It is difficult to assess the exact amount of this increase by lateral radiographs as the apparent kyphosis seen before the operation is often due to rotation rather than true kyphosis. After correction of the rotation by instrumentation, the residual kyphosis is probably true and, in our series, averaged 40 degrees for low thoracic curves, 26 degrees for thoracolumbar curves and 18 degrees for lumbar curves. These figures significantly exceed the normal values for kyphosis or lordosis in the respective areas of the spine. Kyphosis was cosmetically significant in two patients with low thoracic curves who had kyphosis of 66 degrees and 62 degrees, and in one with a thoracolumbar curve who had a kyphos of 48 degrees (Figs 17 to 20). Both the low thoracic curves had their apex at the eighth thoracic vertebra. The attachment of the rib heads to adjacent vertebral bodies in the upper three-quarters of the thoracic spine prevents equal closure of the disc space leading to anterior “hinging” of the vertebrae with resultant kyphosis.

Our conscious effort in the total removal of the disc, posterior annulus and the end plates right back to the posterior longitudinal ligament ensured better bony contact and union. In our 24 curves with an apex below the seventh thoracic vertebra pseudarthrosis did not develop. In the three patients with doubtful union at one level at the time of removal of the body-cast, consolidation occurred without further immobilisation.

Complications associated with Dwyer instrumentation are more formidable than those of Harrington instrumentation. Fatal traumatic aneurysms have been reported (Dwyer 1979; Hall 1981). Retroperitoneal fibrosis with resultant ureteric obstruction and hydronephrosis was reported by McMaster and Silber in 1975. We have not encountered these in this series but retroperitoneal fibrosis and hydronephrosis did develop in one of our patients with paralytic scoliosis after Dwyer instrumentation.

Management of deep infection immediately after anterior instrumentation has been reported previously (Dwyer et al. 1976). In our experience removal of the instrumentation was always necessary to eradicate the infection. In the patient with high thoracic scoliosis who had paraplegia and chronic infection after instrumentation, a sinus continued to discharge until removal of the metal eight years later. Removal of the hardware can be a formidable procedure as the fibrosis associated with the infection usually makes dissection difficult. Continuous irrigation and suction were not used.

Of the four patients with deep infection, three had high thoracic curves and the operations had been done in the early years of the procedure when the hydraulic crimper, which was difficult to sterilise, was used to swage the screw heads. Since the introduction of the mechanical crimper in 1971, only one patient has developed late infection and this was the only serious complication amongst the 24 patients who had curves whose apex was below the seventh thoracic vertebra.

Our experience with this series of patients has shown that Dwyer instrumentation does have certain advantages over Harrington instrumentation in the manage-
ment of adolescent idiopathic curves. The procedure is, however, more formidable and technically demanding, and its complications more hazardous. It certainly should not be used in high thoracic curves but it may have a place in the primary management of thoracolumbar, lumbar or perhaps even some thoracic curves.

REFERENCES