EXCISION OF PROLAPSE OF THORACIC INTERVERTEBRAL DISC
A TRANSTHORACIC TECHNIQUE

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A new technique for the transthoracic removal of a prolapsed intervertebral disc in the mid or lower thoracic spine is described. Investigations before operation include thoracic myelography, selective spinal angiography and CT scanning. Image intensification is used at operation to check the level of the prolapse. A tunnel in the coronal plane (vertebrotomy) is made through the posterolateral part of the disc and the adjacent vertebral bodies, to reach the spinal canal at the site of the prolapse. This gives good exposure and enables gentle removal of the disc prolapse and any associated osteophytes, under direct vision without need for retraction or pressure on the dura or spinal cord. Spinal stability is not compromised, and the blood supply of the cord is not disturbed. Five consecutive patients are reported, including one in whom the disc prolapse was calcified and had herniated into the spinal cord. All were treated successfully.

Poor results from laminectomy for the surgical treatment of prolapse of a thoracic disc have stimulated interest in other approaches, first by costotransversectomy and later, by thoracotomy which provided anterior access. This paper describes a transthoracic technique, developed on the basis of the anterior approach to the spine used in the treatment of vertebral infections, and described by Jackson (1971), and Kemp et al. (1973).

Pressure upon the spinal cord carries the grave risk of permanent cord damage (Dommisse 1980), and may be caused by even temporary retraction of the dura and cord in the relatively narrow thoracic spinal canal. An ideal approach should provide adequate exposure without the need for cord retraction or pressure on the dura. Figure 1 shows that access to even a relatively lateral prolapse via a laminectomy must involve cord retraction; a costotransversectomy would give just adequate access, while a transthoracic approach need not involve displacing dura or cord. A more midline prolapse, as shown in Figure 2, is inaccessible by laminectomy or costotransversectomy and a transthoracic approach is necessary.

The blood supply of the spinal cord has been elucidated by Lazorthes et al. (1971) and more recently by Dommisse (1980), who discussed relevant precautions in spinal operations. The anterior and posterior "medullary feeder arteries" of the spinal cord arise from segmental arteries near the intervertebral foramina, and must always be spared as they have few anastomoses within the spinal canal. The largest and best known of the anterior arteries of the thoracolumbar cord is that of Adamkiewicz (Fig. 3). This artery is on the left in 80% of spines and is nearly always between T7 and L4, usually between T9 and T11. The operation to be described is highly unlikely to disturb this or any other medullary feeder artery, but as a precaution, selective segmental angiography is carried out at the level of the prolapse, to

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Diagram to show access to a posterolateral disc prolapse. An approach from within the arc X to Y would give access to the prolapse under direct vision, without retraction of the dura. Laminectomy or a costotransversectomy approach dividing the rib at BB would require medial retraction of the dura to expose the prolapse. More radical costotransversectomy removing the rib to AA would improve the angle of approach, but the widest access giving the best room for manoeuvre would be via a thoracotomy, in the line T.

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Diagram showing a prolapse just to the left of the midline. The ideal approach is between the two dotted lines. Laminectomy or costotransversectomy would require retraction of the dura and cord.

indicate any possible vessels at risk at the site of operation.

A thoracic myelogram, with lateral tomography, will have been needed to make the diagnosis. A CT scan will show precisely the site of the prolapse in the transverse plane and whether it merely indents or actually herniates into the centre of the cord (Fig. 4). If necessary for clarity water-soluble contrast medium can be injected into the cerebrospinal fluid before CT scanning. The combination of lateral myelography and CT scanning provides the surgeon with an excellent three-dimensional impression of the operation site.

**OPERATION**

A posterolateral thoracotomy allows access to the lateral aspect of the involved disc. A transverse tunnel is made through the disc and adjacent vertebral bone just anterior to the prolapse (Figs 5 and 6). By a combination of dissection and gentle traction, the prolapsed fragment is withdrawn under direct vision without pressure on or retraction of the dura or the cord. A double-lumen

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Figure 4—Case 3. CT scan without contrast, to show a midline prolapse which has herniated into the centre of the spinal cord compressing it into a thin surrounding shell. Figure 5—Lateral view of two vertebrae to show the starting area (V) for the tunnel of the vertebrotomy. Figure 6—Diagram of transverse section at the level of the vertebrotomy showing how removal of the posterior wall of the tunnel (shaded), exposes the prolapse. A better angle of access can be gained by removing the anterior corner (C).
endotracheal tube is used, when possible, to enable the exposed lung to be collapsed. If this tube is contra-indicated, the inflated lung is simply retracted.

A posterolateral prolapse is always approached from the ipsilateral side. A midline prolapse may be approached from either side, though if it is at the same level as the artery of Adamkiewicz, the approach is made from the other side. The patient is placed on the operating table in the lateral thoracotomy position with the involved segment over the bridge which is raised to facilitate exposure. The position of the patient and of any supports should allow room for the use of an image intensifier in anteroposterior and lateral planes or, failing this, radiographs in the same planes.

The level of the thoracotomy is chosen to give perpendicular access to the affected disc. A horizontal line drawn on a recent chest radiograph from the involved disc to the lateral margin of the ribcage will there intersect a rib which, numerically, will usually be two above the level of the disc in the lower thoracic spine and one to two above it in the midthoracic region. The chest is then entered through the space above the indicated rib, erring cranially if in doubt, as it is easier to work in a slightly caudal direction in the chest. Above the 5–6 rib space direct exposure is too restricted, and for T4–5, T5–6 and T6–7 discs the exposures should be through the 5–6 rib space.

The line of the posterolateral thoracotomy incision is marked on the skin and the level checked by using a metal marker and the anteroposterior image intensifier.

An incision is made down to the chosen rib which is verified by a careful rib count. If any doubt remains a further radiological check is advisable. The chest is then opened along the cranial edge of that rib after incising and reflecting the periostea. A 1 cm segment of rib from just lateral to the angle is removed subperiosteally to facilitate spreading of the ribs. The pleural cavity is examined to exclude any unexpected abnormality.

Apart from possible osteophytes, there is no local intrathoracic abnormality produced by the prolapsed disc which will help in the essential confirmation of level. A needle is therefore inserted into the suspected disc and the level confirmed radiologically. The parietal pleura is then incised along the disc and the overlying head of the rib, and is reflected and held aside by short Kirschner wires placed in the adjacent vertebral bodies. Care is taken to avoid the segmental blood vessels. The head of the rib where it overlies the lateral aspect of the disc is removed. At T10–11 and T11–12 the head of the rib articulates with only its own vertebral body, and removal of the cranial portion of the head may suffice.

The lateral aspect and the posterolateral corner of the disc are now exposed. A square window about 1.5 cm wide, and as high as the disc plus any protruding posterior osteophytes (Fig. 5), is cut posteriorly in the lateral wall of the disc and neighbouring bone. This window is deepened in the coronal plane, just anterior to the spinal canal, to form a tunnel which passes beyond the area of the prolapse and any associated osteophytes (Fig. 6). Doubt as to the direction or depth of the tunnel can be resolved by inserting a probe and using the image intensifier. The posterior wall of the tunnel is then carefully removed until all the prolapsed disc material as well as any osteophytes have been removed, and the dura and cord have been completely decompressed. A high-speed Stryker burr, a sharp curette and a dural elevator are particularly useful instruments. If there are no osteophytes, theoretically only the disc needs guttering, but the disc space is usually so narrow that some bone removal is required to allow the comfortable and safe use of instruments under direct vision.

If an important medullary feeder artery enters the intervertebral foramen at the same level and on the same side as the prolapse, great care is needed to avoid arterial damage. If bleeding occurs it must be precisely controlled with bipolar diathermy. Some oozing from cut bone surfaces is usual and to avoid any possibility of dural pressure from a haematoma, the pleura is only loosely approximated. The intercostal nerves above and below the level of the excised rib segment are infiltrated with 0.5% Marcaine. The chest is closed after insertion of a posterolateral basal drain, which is attached to a water seal. After operation, physiotherapy is relatively pain-free because of the intercostal blocks. It is usually possible to remove the drain in 24 to 48 hours and then to mobilise the patient within the limits of any pre-existing neurological deficit. If the dura has been opened then mobilisation is delayed. In Case 3, whose CT scan (Fig. 4) shows a calcified prolapse deeply embedded in the cord, the dura was opened during removal of the prolapse. The dural defect was covered with a layer of Lyodura and Surgicel and a cerebrospinal fluid drain was inserted by lumbar puncture (Matricali 1980). Postoperatively she was nursed in the Trendelenburg position for 10 days whilst the dura healed. The drain was then removed and the patient allowed up.

RESULTS

Clinical details of five patients, having consecutive operations, are summarised in Table I. Their follow-up ranges from one to three years and all patients were improved. Two patients (Cases 4 and 5) were completely free of symptoms and have returned to normal activity, with results which were considered to be excellent. Two patients (Cases 1 and 3) had considerable relief of symptoms but had some residual weakness or spasticity and were classed as having good results. In Case 3, whose CT scan is shown in Figure 4, the residual symptom was limited to difficulty in jumping for the ball whilst playing tennis! The remaining patient (Case 2) was still improving one year after operation, but as he still requires one crutch he has been assessed at this stage as having a fair result. Bladder function in the two patients with incontinence before operation has returned to normal.
EXCISION OF PROLAPSE OF THORACIC INTERVERTEBRAL DISC

Table I. Clinical details of five patients undergoing excision of the thoracic disc

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Site of pain</th>
<th>Sensory changes</th>
<th>Weakness</th>
<th>Gait</th>
<th>Tendon Reflexes</th>
<th>Plantar Reflexes</th>
<th>Urinary symptoms</th>
<th>Duration of symptoms</th>
<th>Myelogram and CT scan</th>
<th>Level of prolapse</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>M</td>
<td>None</td>
<td>Right leg</td>
<td>Right leg</td>
<td>Difficult</td>
<td>+</td>
<td>Normal</td>
<td>+</td>
<td>None</td>
<td>1.5 years</td>
<td>Right anterolateral compression</td>
<td>T5-6</td>
</tr>
<tr>
<td>2</td>
<td>62</td>
<td>M</td>
<td>Thoracolumbar spine</td>
<td>Both feet</td>
<td>Both legs</td>
<td>Using 2 crutches</td>
<td>Normal</td>
<td>Normal</td>
<td>+</td>
<td>Urge incontinence</td>
<td>3 years</td>
<td>Anterior compression</td>
<td>T11-12</td>
</tr>
<tr>
<td>3</td>
<td>39</td>
<td>F</td>
<td>Low thoracic spine</td>
<td>Bilateral below T12</td>
<td>Chiefly L5 and SI</td>
<td>Unsteady</td>
<td>+</td>
<td>(Clonus)</td>
<td>+</td>
<td>(Clonus)</td>
<td>4 years</td>
<td>Anterior compression (complete block)</td>
<td>T9-10</td>
</tr>
<tr>
<td>4</td>
<td>21</td>
<td>M</td>
<td>Bilateral intercostal neuralgia on left</td>
<td>Both legs</td>
<td>Lhermitte's sign positive</td>
<td>None</td>
<td>Unsteady</td>
<td>Normal</td>
<td>Normal</td>
<td>↓</td>
<td>None</td>
<td>7 months</td>
<td>Left anterolateral compression</td>
</tr>
<tr>
<td>5</td>
<td>47</td>
<td>F</td>
<td>Intercostal neuralgia on left</td>
<td>None</td>
<td>None</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>↓</td>
<td>None</td>
<td>7 months</td>
<td>Left anterolateral compression</td>
<td>T11-12</td>
</tr>
</tbody>
</table>

* Onset after a parachute accident

DISCUSSION

Thoracic disc prolapse is rare, with an estimated incidence of one per million population per year (Carson, Gumpert and Jefferson 1971; Jefferson 1975). It is being diagnosed more often as a result of increased awareness and improved diagnostic techniques. Surgical approaches to the prolapse have been by laminectomy, by costotransversectomy, or through the chest.

Laminectomy has given bad results, with roughly half of the patients improved, one quarter worse (and sometimes paraplegic), and the remainder unchanged (Logue 1952; Love and Schorn 1965; Perot and Munro 1969; Benson and Byrnes 1975; Shaw 1975). Patients with laterally placed prolapses which are easier of access by this route, fared better.

Costotransversectomy and other posterolateral approaches came into use because of the poor results of laminectomy (Hulme 1960; Carson, Gumpert and Jefferson 1971; Benson and Byrnes 1975; Jefferson 1975). Results were subsequently improved: a lateral prolapse could be removed with less displacement of dura and cord, but for a midline prolapse, especially one invaginating the dura and eroding the cord, these approaches were still inadequate. A transthoracic approach was the logical alternative. Although an anterior approach for lumbosacral tuberculosis was reported by Müller as early as 1906, it was Hodgson and Stock (1956, 1960) who established the anterior approach to the spine. Crafoord et al. (1958) described transthoracic fenestration of a disc to remove nuclear remnants (but not the actual prolapse), with rapid recovery of their patient. Successful transthoracic removal of prolapsed disc fragments was described in two cases by Perot and Munro (1969) who also used a transverse vertebral trough, and in three cases by Ransohoff et al. (1969). More recently Otani et al. (1982) reported an impressive series of 15 patients, in all of whom favourable results were obtained by using a transthoracic extrapleural approach. The exposures described in these three reports, which included division of intercostal arteries in the first two and the need for interbody fusion to restore stability in the third, were rather extensive.

Prolapse of thoracic intervertebral discs usually occurs in the mid or especially the lower thoracic spine; few cases have been reported above T4. Table II gives the segmental level of 215 cases below T4 collected from previous reports (Logue 1952; Hulme 1960; Tovi and Strang 1960; Love and Schorn 1965; Carson, Gumpert and Jefferson 1971; Benson and Byrnes 1975; Ongerboer de Visser et al. 1978; Otani et al. 1982) as well as the present series.

The approach described in this paper provides excellent access from T6 to T12, and release of the crus of the diaphragm readily exposes the T12-L1 level. At these levels, instruments can be used comfortably at right

Table II. Distribution of 215 collected cases of prolapsed mid and lower thoracic intervertebral discs

<table>
<thead>
<tr>
<th>Level</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>T4-5</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>T5-6</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>T6-7</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>T7-8</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>T8-9</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>T9-10</td>
<td>36</td>
<td>17</td>
</tr>
<tr>
<td>T10-11</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>T11-12</td>
<td>49</td>
<td>23</td>
</tr>
<tr>
<td>T12-L1</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>215</td>
<td>100</td>
</tr>
</tbody>
</table>
angles to the spine. For T4-5 and T5-6 discs, some cranial angulation of the instruments is necessary since, as discussed above, the fifth intercostal space is the highest for adequate access to the spine. For the rare posterolateral prolapse above T4 we have used a costotransversectomy.

A particularly difficult problem is presented when a midline prolapse has herniated through the dura into the cord, as in Case 3 (Fig. 4). This type of lesion was mentioned by Fisher (1965), and by Love and Schorn (1965). Jefferson (1975) reported two such cases, one of whom, with a calcified prolapse, sustained severe cord damage during operation through a posterolateral approach. The transthoracic technique is particularly useful in such cases, providing as it does, good exposure with room to manoeuvre instruments, including high-speed burrs, comfortably under direct vision.

From the literature and from our experience it seems that a laminectomy approach for the removal of a thoracic disc prolapse is now obsolete, and that below T4 a transthoracic approach is best for a midline prolapse and probably also for lateral prolapse, though for the latter a posterolateral approach may suffice, but gives limited access. The transthoracic approach and technique described above is simpler than the other transthoracic techniques described and is just as effective. The vertebrotomy may safely be extended if this is necessary for the removal of a sequestrated disc fragment. Even then, sufficient bone and annulus remain around the vertebrotomy tunnel to maintain spinal stability.

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REFERENCES


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