Controversy surrounds the aetiology of obstetric brachial plexus lesions. Most authors consider that it is caused by traction or compression of the brachial plexus during delivery. Some patients, however, present without a history of major traction during delivery, and some delivered by Caesarean section also suffer the injury.

In our series of 42 infants, 28 had an Erb’s palsy, and the remaining 14 presented with a more extensive lesion, involving the lower roots. In five of these, a complete ossified cervical rib was found.

We believe that anatomical variations, such as cervical ribs or fibrous bands, can cause narrowing of the supracostoclavicular space, and render the adjacent nerves more susceptible to external trauma.


Since the early descriptions by Duchenne in 1861 and 1872 and Erb in 1874, many workers have discussed the aetiology of obstetric brachial plexus palsy. At the beginning of the 20th century, the term ‘Entbindungslähmung’ (laming at delivery) was coined, referring to the intra-partum origin of the lesion. Further observations by Czurda and Meznik confirmed this theory. Sjöberg, Erichs and Bjerre described the lowest prevalence of this lesion (48 of 25 736 births) in Sweden and distinguished between temporary and permanent lesions. A high birth weight (> 4200 g) and a relatively large cranial circumference are considered to be associated with permanent lesions. In diabetic mothers with macrosomic infants, the risk increases to more than 10%.

Most authors regard the traction necessary to overcome obstructed labour to be the major cause of brachial plexus palsy. Others consider compression of the shoulder to be the major factor. The variety of associated lesions which has been documented in the presence of brachial plexus palsy supports these theories. Fractures of the clavicle (3.2%), cervical haematoma, torticollis, Horner’s syndrome, fractures of the humerus, posterior subluxation of the shoulder and even spinal injury have been reported.

Although a traction injury is a major factor in obstetric brachial plexus injury, this explanation is inadequate for all patients. Direct compression by the septum of a bicornuate uterus has been described by Dunn and Engle in a neonate who presented with brachial plexus palsy, rib deformities, and calcification of the subcutaneous tissues of the neck. The literature contains still further suggestions of pathogenic mechanisms in infants delivered by Caesarean section.

The intraoperative findings in infants with total or sub-total brachial plexus palsy, and comparable findings in adults with thoracic outlet compression syndrome, prompted us to examine the possibility that anatomical variation may be a significant factor (Fig. 1).

Studies relating to thoracic outlet compression syndrome refer almost exclusively to adults. The frequency of such bony anomalies as a cervical rib, bifid first rib or fusion of the first and second ribs in the population is about 0.5%. Compression of neurovascular structures may also be caused by fibrous bands. In another study, radiological examination of fetuses showed separate costal elements in 63% of cases. Since other skeletal variations could be detected in only 17%, the authors considered that these may disappear after birth. Clinically, these inborn structures do not cause problems in childhood, but can become symptomatic if the supracostoclavicular space narrows.

We have therefore examined 42 patients with obstetric brachial plexus lesions in an attempt to determine predisposing factors.

 Patients and Methods

Of 42 infants who underwent surgery for obstetric brachial...
plexus palsy, 28 presented with an Erb’s palsy, the pathology being restricted to the shoulder and biceps muscles. The remaining 14 infants had partial or total lesions, including triceps palsy and/or additional lesions of the forearm and hand. Intraoperatively, the infants with Erb’s palsy revealed typical damage to the C5/C6 nerve roots and the superior trunk. If damage to the lower roots was present it was only marginal. By contrast, the remaining infants with extensive clinical findings had substantial damage at the root and trunk levels. There were no isolated Klumpke’s lesions.

Results

Complete cervical ribs were present in five infants (Figs 2

Fig. 1

Diagram showing neural structures in the supracostoclavicular space. The normal anatomical situation is reduced to the spine, the first rib and the nerves. The clavicle is not shown, nor are the phrenic nerve, the sympathetic fibres, the dorsal scapular nerve and the branches of the pectoralis nerve (SSC, supraclavicular nerve; AX, axillary nerve).

Fig. 2

Intraoperative photograph showing the cervical rib (arrow).
3). Histological examination showed ossification and a high bone-marrow content. Four had had a high birth weight (3890 to 4250 g), cephalic presentation and shoulder dystocia. We consider that the lesion was exacerbated by the cervical rib. The fifth child had been born prematurely by a breech delivery with a birth weight of 1870 g, and presented with bilateral upper lesions, no regeneration on the right side and with reinnervated biceps and shoulder muscles on the left after three months. Intraoperatively, on the right side, an intraforaminal rupture of the C5 and C6 roots was suspected while the caudal parts of the plexus appeared to be normal. The cervical rib was complete.

In summary, four of the five infants with a complete cervical rib presented with lesions of the nerves in the narrow space between the first and cervical ribs. In one, there were C8 and T1 root avulsions (Fig. 4), and in three there was fibrosis of grade B to C. Table I gives an overview of the results.

### Table I. Details of the five infants with a complete, ossified cervical rib

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (mths)</th>
<th>Birth weight (g)</th>
<th>Accompanying lesions</th>
<th>Complications during delivery</th>
<th>Preoperative clinical findings*</th>
<th>Intraoperative findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>4090</td>
<td>None</td>
<td>Protracted birth</td>
<td>Complete paralysis except 30° of shoulder flexion</td>
<td>Rupture C5 and C6, subtotal rupture C7, avulsion C8 and T1, complete cervical rib</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>3890</td>
<td>None</td>
<td>Shoulder dystocia</td>
<td>Shoulder flexion 80° Biceps M4, Triceps M4 Spasticity ECR, EDC, EPL M0 Forearm flexors M1/M2</td>
<td>Fibrosis B/C of C5, C6 and upper trunk, subtotal rupture C7, fibrosis C of lower trunk, complete cervical rib</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>4110</td>
<td>None</td>
<td>Shoulder dystocia</td>
<td>Shoulder flexion 20° Fixed flexion contracture of the elbow Forearm M0</td>
<td>Neuroma C5, C6 and C7 Fibrosis B of root C8, T1 and lower trunk. Complete cervical rib</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>4250</td>
<td>None</td>
<td>Shoulder dystocia</td>
<td>Shoulder M0, Pectoralis M3, Biceps M3 Triceps M3, Forearm flexors M3 Forearm extensors M0</td>
<td>Fibrotic neuroma at the level of the trunks, avulsion C7. Triceps and forearm can be stimulated electrically from the caudal parts of the neuroma. Complete cervical rib.</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>1870</td>
<td>Bilateral lesions</td>
<td>Breech presentation</td>
<td>Right: Shoulder M0, Biceps M0, Triceps and Forearm M4/M5 Left: Upper palsy in spontaneous regeneration</td>
<td>Brachial plexus appeared macroscopically normal, no fibrosis or neuroma. No electrical response of the upper roots. Complete cervical rib.</td>
</tr>
</tbody>
</table>

*ECR, extensor carpiradialis; EDC, extensor digitorum communis; EPL, extensor pollicis longus; M, MRC
Discussion

Obstetric brachial plexus lesions are caused by excessive trauma. This is often confirmed by accompanying injuries such as clavicular fractures, haematoma of the sternocleidomastoid muscle or fractures of the humerus. Additional factors have been suggested since lesions of the brachial plexus have been seen after Caesarean section and in infants with cephalic presentation, but without shoulder dystocia. Compression of the neural structures over the first rib or the apophyses of the vertebrae has been described.

In brachial plexus pathology in infants, cervical ribs may aggravate the mechanism of injury in two ways: first, by stretching the nerves around the cervical rib, and secondly, by concentrating pressure on the nerve roots when the shoulder region is forced against the cervical spine. We suggest that these mechanisms may contribute to the lesion in one of three ways. First, caudal extension of the lesion by downward traction of the arm, in combination with external pressure, may also damage the C7 nerve root, by compressing it against the additional bone. Secondly, isolated damage due to external pressure to the cervical region may compress the upper plexus against a cervical rib, thereby concentrating maximum force on the C7 nerve; additional traction in this situation may cause root avulsion (Brunelli’s ‘middle’ lesion). Finally, forced elevation can shear the lower parts of the plexus against a cervical rib, resulting in damage or avulsion of C8 and T1 (Klumpke’s lesion).

Cervical ribs without additional trauma do not cause pathology in infants and remain undiagnosed. They should be as prevalent in children as they are in adults although an incidence of 60% in fetuses suggests that the rib may be analogous to the pharyngeal arch. In our series of 42 infants, five complete cervical ribs represent an incidence which is higher than the 0.5% in the general population. It appears that more than a third of the children with partial or total lesions had a complete cervical rib.

Sloof described two predisposing factors for obstetric brachial plexus palsy: macrosomic infants with a cephalic presentation, with or without shoulder dystocia, who presented with extensive lesions, and macrosomic infants in a breech position with C5 and C6 avulsions, which were frequently bilateral. He suggested that there was axial traction of myelin relative to the bony spine, the nerve roots being fixed in the intervertebral foramina. This last mechanism may apply to the fifth infant in our study who presented with a relatively low birth weight (1870 g), but was delivered in a breech position. In this infant the cervical rib was unlikely to have contributed to the lesion.

We conclude that narrowing of the supracostoclavicular space by anatomical variations, such as cervical ribs or fibrous bands, may be a predisposing factor for brachial plexus lesions in infants, even if the associated trauma is mild.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References

1. Duchenne GB. Du L’electrisation localisée et de son application à la pathologie et à la thérapeutique par courants interrompus et continus. 3 ed. Paris, 1872.