PERSONAL PRACTICE

Spinal cord birth injury – diagnostic difficulties

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Improvements in obstetric care have certainly led to a decrease in the incidence of birth related spinal cord trauma but unfortunately it is still encountered from time to time. Its exact incidence is difficult to determine because the spinal cord is not routinely examined in all necropsies. Yates (1959) found evidence of distortional trauma to the cervical spine in 45% of perinatal necropsies.¹ Towbin (1969) reported significant spinal or brain stem injury in over 10% of neonatal necropsies.² More recently Reid in 1983 reported 48 perinatal necropsies and concluded that although there was no decrease in the incidence of cervical spine trauma in comparison to Yates's series, there was a decrease in the severity of damage in individual cases.³ The incidence of serious spinal cord damage in our region over the last five years is estimated to be approximately one in 29 000 live births.

Presently, the most common scenario for birth related spinal cord injury is after Kielland's forceps rotation for persistent occipitoposterior position of the presenting vertex⁴ (personal experience) in contrast to previous reports where 75% of the cases occurred after breech presentation.⁵ Other predisposing factors include hyperextension of the fetal head,⁶ external cephalic version,⁷ inherent congenital vertebral anomalies,⁸ prematurity,⁹ precipitate delivery,⁹ intrauterine asphyxia,^{9 10} benign congenital hypotonia,¹⁰ and forceps application in presence of oligohydramnios, uterine contraction, or a constriction ring.¹¹ Occasionally spinal cord injury has occurred after an easy, uneventful normal cephalic delivery.^{12 13}

Clinical suspicion of birth related spinal cord injury is often delayed. Diagnosis and management are difficult and there are long term serious medical, legal, and ethical implications. Accurate localisation and assessment of the severity of the lesion is of vital importance in planning the management strategies. There is no single test which determines the site and extent of the lesion in every case and there is considerable discordance in the results of various neuro-diagnostic imaging techniques and also among the different electrophysiological tests.

Site and pathomechanics

The association of spinal cord injuries with difficult breech extraction was obvious even from the earliest reports on the subject.^{14 15}

Obstetric forceps were later incriminated particularly when a rotational component was required to expedite the delivery in cephalic presentation or in difficult extraction of the aftercoming head in breech presentation.^{5 8 11 13} The injury mainly involves cervical and upper thoracic segments and the site of injury is almost always above the brachial attachments if it occurs after cephalic delivery in contrast to more caudal lesions during breech extraction.^{2 8} The difference in the laxity of the spinal cord and vertebral column predisposes the relatively inelastic spinal cord to trauma when subjected to sufficiently severe longitudinal stretch during delivery.² This accounts for spinal cord damage in the absence of any vertebral column injury.^{14 15} In addition, the normally unfused cervical segments of the neonatal spine permit a latitude of motion that cannot occur in the adult spine making it vulnerable to hyperextension, hyperflexion, torsion, and compression during a difficult parturition. Excessive longitudinal traction with lateral flexion in breech and often an element of torsion in cephalic presentations accompanies such traumatic deliveries.^{8 10 11 13}

Approach to diagnosis

Although numerous reports have appeared for over 150 years on the subject of spinal cord injuries, it is only in the last decade that newer diagnostic modalities have been emphasised. A prompt and accurate diagnosis has assumed even greater importance after the recent report of improved prognosis of spinal cord injury after early pharmacological intervention.¹⁶ Sadly the diagnosis of spinal cord injury is often missed early in the neonatal period as neurological signs may be either altered/overshadowed by accompanying hypoxic ischaemic damage or may even be falsely attributed to hypoxic ischaemic encephalopathy. The spinal cord injury is considered only after consciousness improves and typical motor deficits manifest themselves. Even at this stage, a primary neuromuscular disorder may be difficult to differentiate but a history of good fetal movements will render this diagnosis less likely. It is only late in the clinical course that autonomic involvement with disturbance in bladder function and development of progressive spastic paraplegia or quadriplegia make the diagnosis of spinal cord damage obvious.

Various neuroradiological and neurophysiological investigations in combination may be

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Algorithm proposed for use in diagnostic work up of suspected neonatal spinal cord birth trauma. * Electrophysiological tests (electromyography, nerve conduction studies, and somatosensory evoked potentials) may be helpful.

useful in the correct localisation of the lesion. Because of the rarity of this condition there are only a limited number of studies comparing various diagnostic techniques and until quite recently most of the patients died early in the acute stage.

Plain cervical radiographs often give negative results as the spinal cord is often damaged without any evidence of fracture dislocation on plain films.^{4 8 17–19} Franken¹⁷ reported normal cervical spine radiographs in two out of two and Lanska *et al*¹⁸ in two out of three cases with neonatal spinal cord birth trauma. Adams *et al* reported traumatic dislocation or subluxation in only two of eight patients on plain films of the spine.¹⁹

An *ultrasound scan* of the spine is useful in the initial evaluation of neonates with suspected spinal cord injury as incomplete ossification of the posterior vertebral arch allows visualisation of the neonatal spinal cord. Echogenicity changes allow differentiation between initial oedema, haematomyelia, and later myelomalacia. It is an easy, cheap, quick, reproducible, and non-invasive bedside investigation that allows for frequent re-evaluations. Babyn *et al* were able to assess the spinal cord configuration ultrasonographically in all four cases of the spinal cord birth trauma and these correlated with necropsy findings which were available in three of these.²⁰

A *computed tomogram* of the neck evaluates the spinal column (fracture and/or dislocation) better than the cord itself. It may be falsely negative as highlighted in a recent report by McKinnon *et al*⁴ and Lanska *et al*¹⁸ who did not find any abnormality in the computed tomogram of the neck in one of the three cases in which it was performed.

A *computed tomographic myelogram* has been used to confirm the diagnosis and identify the level of the lesion. It gives only indirect evidence of the spinal cord injury but provides better information on nerve root injuries such as brachial plexus avulsion. It is also known to give false negative results, is associated with a

higher frequency of complications, does not define the underlying pathology, and the level of spinal cord block may not correspond to the level of the lesion.¹⁸ Adams *et al* reported abnormal myelograms in eight infants with spinal cord birth injury but these results did not contribute to alteration in management in any of these patients.¹⁹

Magnetic resonance imaging (MRI) despite its high cost and unique logistics has been suggested as the investigation of choice because of its better soft tissue delineation, avoidance of radiation exposure, and its capacity to provide information on fracture dislocation of the spinal column.¹⁸ Bloom *et al*²¹ reported abnormal MRI in two and Lanska *et al*¹⁸ in three cases with spinal cord birth injury. We would exercise caution in the interpretation of normal early MRI in the presence of a clinically suspected spinal cord injury as highlighted in a recent report by McKinnon *et al*.⁴

Electrophysiological studies (electromyography, nerve conduction, somatosensory evoked potentials) although non-specific, may provide supportive evidence for the suspected level of the lesion. Their main value is in the localisation of the lesion in diseases affecting the anterior horn cell, peripheral nerve, neuromuscular junction, and the muscle.²² Usefulness of somatosensory evoked potentials in cervical cord lesions is limited as cervical bioelectric potentials are typically small and one third of even normal term neonates may fail to show scalp potentials overlying the somatosensory cortex.²³ Somatosensory potentials were reported as abnormal in two of the three cases of Lanska *et al*.¹⁸

The choice of diagnostic tests is difficult and will depend upon their local availability. We propose an algorithm (figure) to be used in the diagnostic work up of suspected neonatal spinal cord birth trauma. An ultrasound scan of the neck is our investigation of choice in the acute stage. If abnormal, we recommend follow up by serial scans in the acute stage, followed by MRI subsequently at a few weeks

of age. If the initial ultrasound scan is normal, MRI is our next investigation of choice. If the MRI fails to detect spinal cord damage in the acute stage we advise repeating the ultrasound scan as well as the MRI later as initial scans are known to be falsely negative. In those cases where clinical suspicion is strong but radiological data is normal, the electrophysiological tests mentioned earlier may be helpful in identifying a lesion and localising its site. If there is still clinical/neuroradiological or neurophysiological discrepancy, computed tomography with or without a myelogram is recommended.

The approach outlined above with emphasis on clinicoimaging correlation rather than on any one particular investigation is likely to be the most useful. With the suggestion that pharmacological intervention early in acute spinal shock may be beneficial,^{16 24-26} we should keep a high index of suspicion of spinal cord injury in every neonate with abnormal neurological status particularly after a difficult delivery or a rotational manoeuvre. Antenatal documentation of good fetal movements, knowledge of delivery details, and thorough neurological examination complimented by neuroradiological and neurophysiological tests as outlined above should provide the correct diagnosis in order to plan the management strategies.

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