

Obstetric neurological injuries

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Accepted on 27 December 2019. Published online 21 September 2020.

Key content

- Neurological injuries following well-managed labour and childbirth are uncommon but potentially serious.
- Anaesthetists are often called to see these patients because of concerns about the complications of regional anaesthesia; however, 'obstetric' neurological injuries, caused by nerve compression during labour and childbirth, are much more common.
- From a global health perspective, neurological injuries are part of the obstructed labour injury complex.
- After ruling out a complication of regional anaesthesia, most obstetric neurological injuries can be managed with reassurance and/or physiotherapy.

Learning objectives

- To review knowledge of the nerve pathways in the pelvis and discuss how they can be damaged specifically in obstetric practice.
- To understand how to diagnose obstetric neurological injuries and distinguish these from anaesthesia-related nerve injuries.
- To understand how to counsel patients with obstetric neurological injuries and how to investigate and treat them.

Ethical issues

- Major disparities in maternal and perinatal health outcomes persist both within and between countries; clinicians in the UK have a role to play to help improve outcomes for underprivileged women in the UK and abroad.

Keywords: intrapartum care / obstetric neurological injuries / obstructed labour injury complex / regional anaesthesia

Please cite this paper as: Harper RLC, Eckford SD, Williams H, Leach OA. Obstetric neurological injuries. *The Obstetrician & Gynaecologist* 2020;22:305–12. <https://doi.org/10.1111/tog.12696>

Introduction

Neurological injury is an uncommon but potentially serious complication of childbirth. It was first reported in the *Second report of the new Lying-in Hospital, Dublin* in 1938.¹ In this case, the woman seems to have had a relatively straightforward, 7-hour labour, but presented postnatally with paralysis and anaesthesia of her right leg. Various treatments were attempted (including 'frictions, with warm turpentine', 'a course of blisters along the line of the sciatic nerve' and rudimentary physiotherapy) and within 2 months, use of her leg had mostly recovered. Sadly, during the 2 months in which the woman was an inpatient, an epidemic of puerperal fever hit the hospital, and she died of pericarditis as a result.

Numerous case reports and case series have followed this first account,^{2,3,4} and – to this day – postpartum patients occasionally present with neurological symptoms. In our experience, anaesthetists are commonly asked to review these patients because of the concern that leg weakness or numbness may be

associated with a serious complication of regional anaesthesia. However, obstetric processes, rather than anaesthetic ones, are far more likely to be the cause of neurological injuries.⁵ Therefore, obstetricians should be knowledgeable of the causes, presentation, diagnosis, prognosis and treatment of these injuries.

Epidemiology of postpartum nerve injuries

The reported incidence of nerve injuries following labour and delivery varies depending on the means of diagnosis and thoroughness of follow-up. The highest reported incidence of obstetric neurological injury is 2%. This was from an Australian study, conducted in 2017, of 1019 women who were prospectively asked about and examined for neurological symptoms and signs, within 32 hours of delivery.⁶ Despite the high incidence, the neurological symptoms reported were all mild and resolved quickly and therefore none were clinically important. A lesser incidence of 0.92% was reported in a US study conducted by Wong in

2003.⁷ In this study of 6048 parturients, women were asked about their neurological symptoms the day after delivery. The populations involved in these two studies may have had different risk factors for obstetric neurological injuries, thus explaining the difference in reported incidences. However, the larger population screened in Wong's study means this figure is more commonly cited.

This incidence is compared with a risk of neurological injury in up to 1:25 000 (0.004%) obstetric regional anaesthetics.^{8,9} Quoted figures in the anaesthetic literature derive from studies such as the UK's National Audit Project 3 (NAP3) of the Royal College of Anaesthetists. This study relied on clinicians reporting all complications related to regional anaesthesia over a period of 1 year, compared with a denominator of the estimated number of procedures performed that year. The method of case ascertainment was therefore different to the prospective data for obstetric causes, but necessarily so for such rare complications.

Peripheral nerves are vulnerable to injury by compression, ischaemia or transection. In obstetrics, compressive neuropathies are most common, with the most commonly affected nerve being the lateral cutaneous nerve of the thigh. Other susceptible nerves are the femoral nerve, common peroneal nerve, lumbosacral plexus, sciatic nerve and obturator nerve.⁷ The frequency of injury of any one nerve is related to its vulnerability to injury by obstetric processes. A previous article published in *The Obstetrician and Gynaecologist* reviewed neurological injuries related to gynaecological surgery,¹⁰ which occur in 1.1–1.9% of cases; clearly, obstetric operations may also lead to nerve damage caused by trauma to the nerves in the pelvic side wall.¹¹ However, in most cases, obstetric nerve damage is caused not by an obstetric intervention but by nerve compression between body structures, between the fetal head and the bony pelvis or between the body and external structures (for example, lithotomy supports).^{12,13}

There have been reports of obstetric neurological injuries associated with cephalopelvic disproportion, malposition of the fetal head, prolonged second stage of labour and instrumental delivery. Regional anaesthesia is also associated with these injuries – an indirect consequence, since women with dense neuraxial block change their position less often, tend to push in the lithotomy position, have more instrumental deliveries and are less aware of paraesthesia or other symptoms of impending nerve damage.^{2,7,11} These risk factors could all cause more prolonged or severe compression of the pelvic nerves between the fetal head and the pelvic side wall.

With modern obstetric care, excessively prolonged second stages of labour and difficult forceps deliveries have become less common, so it would be expected that neurological injuries would have declined in incidence in the UK.

However, recent papers have reported an increasing incidence.^{5,6} This may be associated with changes in maternal risk factors (for example, obesity) or simply better case finding.

There are no figures for the incidence of obstetric neurological injuries in low- and middle-income countries. In some impoverished communities with poor access to care in labour and delivery, neurological injuries may be more common, more severe and longer lasting, but it is impossible to know. In one Nigerian prospective series of 470 women admitted for repair of obstetric fistula (who had therefore undergone a neglected obstructed labour), 65% had either current or previous symptoms of nerve injury.¹⁴ In this series of patients presenting for fistula repair 2 or more years after delivery, 13% still had a neurological injury, such as foot drop. In another series, walking problems were seen in 29% of those with fistula,¹⁵ a hard-to-imagine burden of disability.

Neurological injuries relating to labour anaesthesia are rare but potentially devastating. They include direct damage to the spinal cord or nerve roots, epidural haematomata or abscess, meningitis or arachnoiditis. They have been thoroughly discussed in the anaesthetic literature^{16,17} and will be outlined here because of their importance when constructing a differential diagnosis.

Pathophysiology of neurological injuries

Within a peripheral nerve, individual myelinated axons are surrounded by connective tissue called endoneurium (Figure 1). A connective tissue sheath called the perineurium surrounds multiple axons and associated endoneurium. The entire bundle is known as a fascicle. In large nerves, such as those that can be damaged during labour and delivery, multiple fascicles, fat and the vasa nervorum (an individual blood supply), are bundled together and surrounded by a further connective tissue layer, the epineurium. The connective tissue layers and the muscles and fat surrounding the nerves provide the nerve with some protection. However, nerves remain vulnerable to trauma or prolonged, often minor, compression.

A system of classifying nerve damage was proposed by Seddon in 1942¹⁸ and modified by Sunderland in 1951.¹⁹ Both versions of the system are still used, although neurological injuries probably occur on a continuum rather than in discrete degrees of severity (Figure 2). Fortunately, most obstetric neurological injuries are mild: **Seddon's neurapraxia or Sunderland's class I. Neurapraxia is caused by milder or short-lived blunt injuries to nerves (such as those that occur when the fetal head compresses a pelvic nerve against the bony pelvis) and refers to damage to individual neurons and/or their myelin sheaths, with a block in nerve conduction but without axon or perineurium**

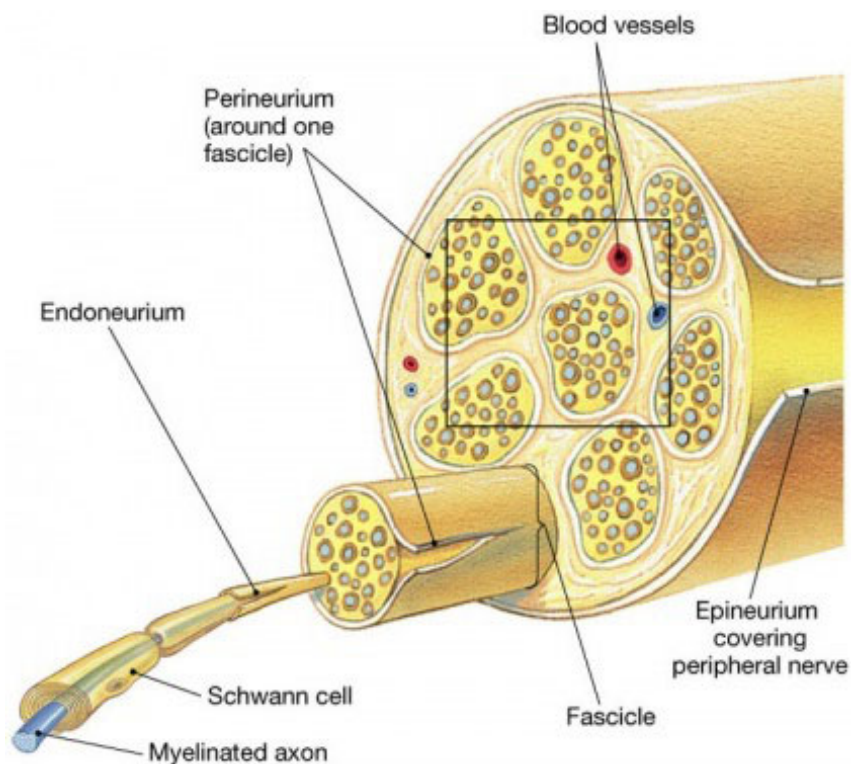


Figure 1. Structure of a peripheral nerve.

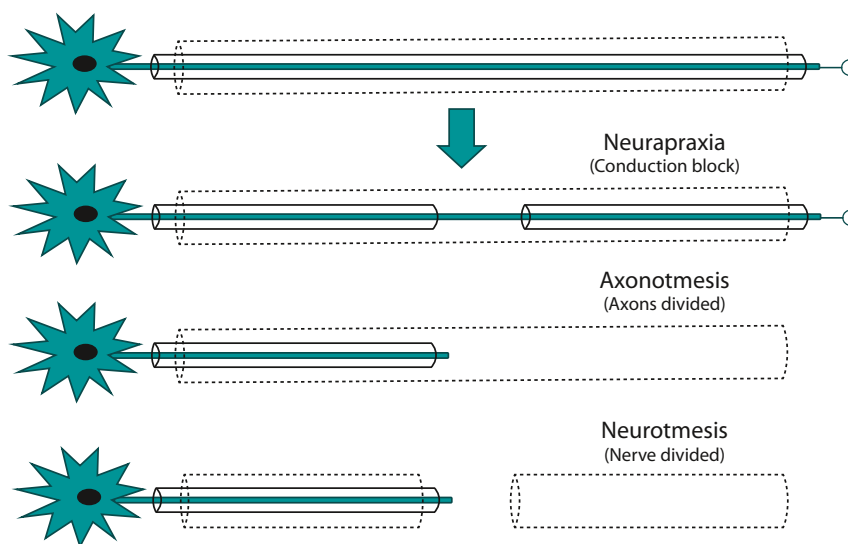


Figure 2. Classification of the severity of nerve injuries.¹⁸

disruption. Axonotmesis and neurotmesis refer to more severe nerve damage, which is rarely associated with childbirth. Nerve injury prognosis is related to severity; with neurapraxia, complete recovery through remyelination typically occurs in days to weeks, as seen with most obstetric neurological injuries.^{20,21}

Nerves involved in obstetric neurological injuries

Lateral cutaneous nerve of the thigh

The lateral cutaneous nerve of the thigh is an entirely sensory nerve arising from **L2/L3** and running under the lateral end

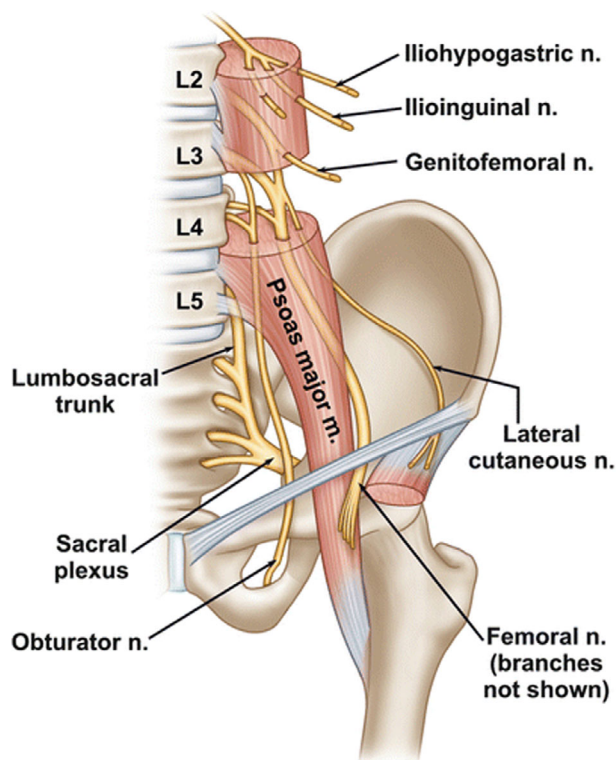


Figure 3. Anatomy of lumbosacral plexus and pelvic nerves.

of the inguinal ligament (Figure 3). Compression of the nerve as it exits the pelvis under the inguinal ligament can result in meralgia paraesthetica²², a syndrome of sensory symptoms in the lateral thigh, the cutaneous distribution of the nerve (Figure 4). Patients report symptoms, including numbness, pain, paraesthesia, hyperalgesia and hypersensitivity to heat. Specific to this condition, there are no motor symptoms, the sensory changes do not cross the midline of the thigh and the symptoms can be reproduced by pressure or Tinel's test on the lateral inguinal ligament. Meralgia paraesthetica can occur during the latter half of pregnancy or postpartum because of increased intra-abdominal pressure and/or prolonged hip flexion compressing the nerve. Risk factors include obesity and diabetes, which can increase compression of the nerve.

Treatment relies on relieving nerve compression. Patients can be advised to lose excess weight and wear loose clothing. In cases occurring in late gestation or labour, delivery of the fetus, the passage of time and simple analgesia should suffice. Local corticosteroid injections, neuropathic pain medications (for example, amitriptyline, which is safe in breastfeeding) and, in severe cases, surgical decompression may also be needed.

Lumbosacral trunk

The lumbosacral trunk arises from L4/L5 and runs over the posterior pelvic brim and down the sacral ala to join the sacral nerves and contribute to the sacral plexus. The lumbosacral trunk can be compressed between the sacrum and the fetal head or obstetric forceps. Fetal malposition and relative cephalopelvic disproportion are, therefore, risk factors for such injuries. The nerve fibres that are usually damaged contribute to the common peroneal nerve; therefore, lumbosacral trunk injuries cause foot drop and paraesthesia, or loss of sensation along the lateral calf and foot, which is usually unilateral. However, careful examination often shows mild weakness in other areas, such as knee flexion, hip abduction, extension and internal rotations. This enables lumbosacral trunk lesions to be distinguished from pure common peroneal nerve injuries. There may also be deep, boring pain in the pelvis, related to the site of injury. If the diagnosis is unclear, nerve conduction studies are needed.

The injury is usually a compression neuropathy, so provided that labour has not been excessively prolonged, the prognosis is usually excellent. Treatment relies on physiotherapy and neuropathic pain medications.

Femoral nerve

The femoral nerve arises from L2/L3/L4. It emerges from the lateral border of the lower part of psoas major and runs between the psoas and iliacus muscles to pass under the midpoint of the inguinal ligament. The nerve supplies motor function to the anterior thigh muscles and sensory function to the anterior thigh, as well as to the medial calf by its saphenous nerve branch. The course it takes means that femoral nerve injuries are caused by stretching or compression at the inguinal ligament rather than compression between the fetal head and pelvis. Femoral neuropathy results in weakness of knee extension with or without hip flexion, and pain, paraesthesia, or loss of sensation in the anterior thigh and medial calf. Patients report a tendency for the knee to 'give way' and difficulty climbing stairs. Knee reflexes will be impaired.

Femoral nerve lesions can be bilateral in up to 25% of cases,¹² although bilateral symptoms postpartum should always prompt urgent investigation with magnetic resonance imaging (MRI) to rule out a central lesion. Lesions to the nerve roots (radiculopathy) of the upper lumbar plexus (L2/L3) and retroperitoneal lesions, such as haematomata or tumours, may present predominantly with femoral nerve symptoms. It is therefore important to bear this in mind when considering a diagnosis of femoral neuropathy. However, both differentials will cause nerve symptoms from outside the femoral territory, in the obturator or lateral cutaneous nerve of the thigh. Retroperitoneal lesions

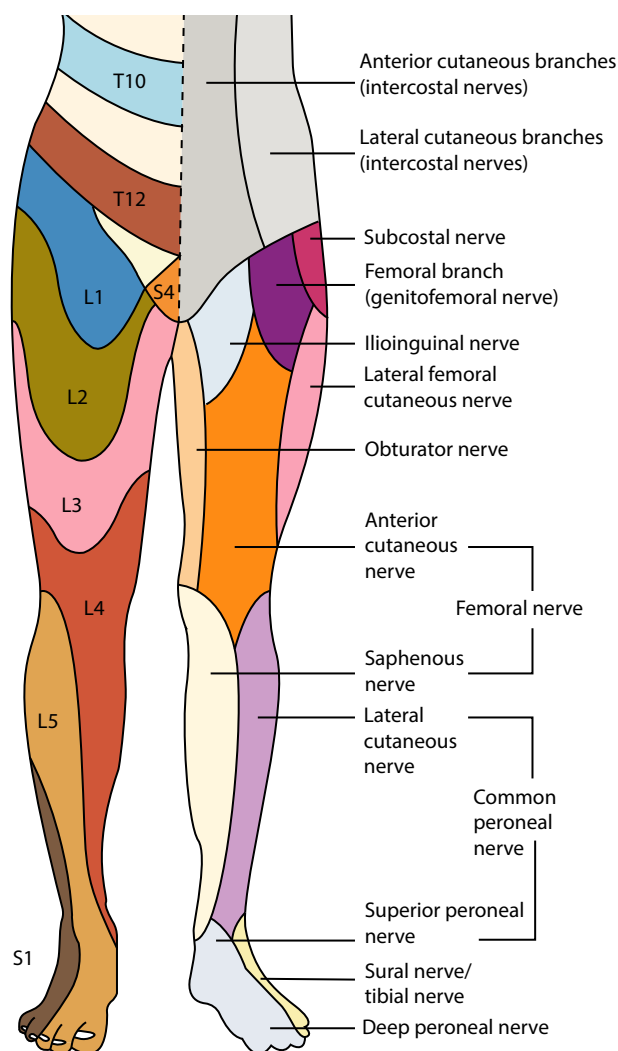


Figure 4. Distribution of lower limb sensory nerves.

will usually also present with back pain. Careful neurological examination is therefore always required.

Neuropathic pain from the femoral nerve can be treated with simple analgesia, neuropathic pain medication or femoral nerve blocks. Muscle weakness resulting in the knee 'giving way' can be managed with physiotherapy and a knee brace for support. The prognosis is usually excellent.

Obturator nerve

The obturator nerve arises from the anterior divisions of L2/L3/L4. It runs from the medial border of psoas major to the obturator canal and, because it enters the true pelvis, it can also be damaged by compression by the fetal head. The lithotomy position stretches the nerve as it exits the obturator foramen and therefore may also predispose to injury. The obturator

nerve supplies motor nerves to the hip adductors and sensory nerves to the medial portion of the thigh. Obturator neuropathy is bilateral in around 25% of cases and results in isolated weakness of hip adduction and loss of sensation over the medial thigh. Treatment involves physiotherapy and reassurance; the prognosis is usually excellent.

Common peroneal nerve

The common peroneal nerve arises from the sciatic nerve in the posterior thigh and is vulnerable to compression (for example, from lithotomy supports) or traumatic injuries when it runs around the head of the fibula to reach the anterior calf. It supplies motor nerves to the muscles of the anterior and lateral compartments of the leg and sensory nerves to the anterior and lateral leg and foot. Therefore, common peroneal neuropathy causes foot drop and impaired sensation over the lateral and anterior calf and foot. As noted above, pure common peroneal nerve injuries must be carefully distinguished from lumbosacral trunk injuries by examination and – possibly – by nerve conduction studies. They should also be distinguished from injuries of the sciatic nerve, which will cause hamstring weakness and sensory/motor symptoms in the anterior/lateral/posterior lower leg, not just the anterolateral areas that are innervated by the common peroneal nerve.

Patients classically develop a high stepping gait to compensate for foot drop, but remain vulnerable to trips and falls. An ankle foot orthosis (AFO brace), supplied by a physiotherapist, will help reduce the risk.

Neurological injuries related to obstetric anaesthesia

Given the potential for greater trauma, nerve injuries are more common with epidural than spinal anaesthesia.^{9,16} The most common anaesthetic-related injury is traumatic injury to the spinal cord, conus medullaris or the nerve roots because of accidental damage during insertion of the spinal/epidural needle. Trauma results in pain, paraesthesia, anaesthesia and weakness in the distribution of the affected nerve root.

Rare but devastating complications include vertebral canal haematoma and abscess formation. Haematomata may occur when the anaesthetic needle or catheter damages the epidural venous plexus. They present early as the expanding haematoma compresses nerve fibres within the vertebral canal. Epidural abscesses result from the introduction of pathogens into the epidural space. Abscesses take time to develop so tend to present later. Both of these scenarios are rare with careful practice, including attention to coagulopathies, timing of anticoagulation therapy and scrupulous asepsis. By compressing the spinal cord/cauda equina and spinal nerves, they present with back pain and tenderness and bilateral

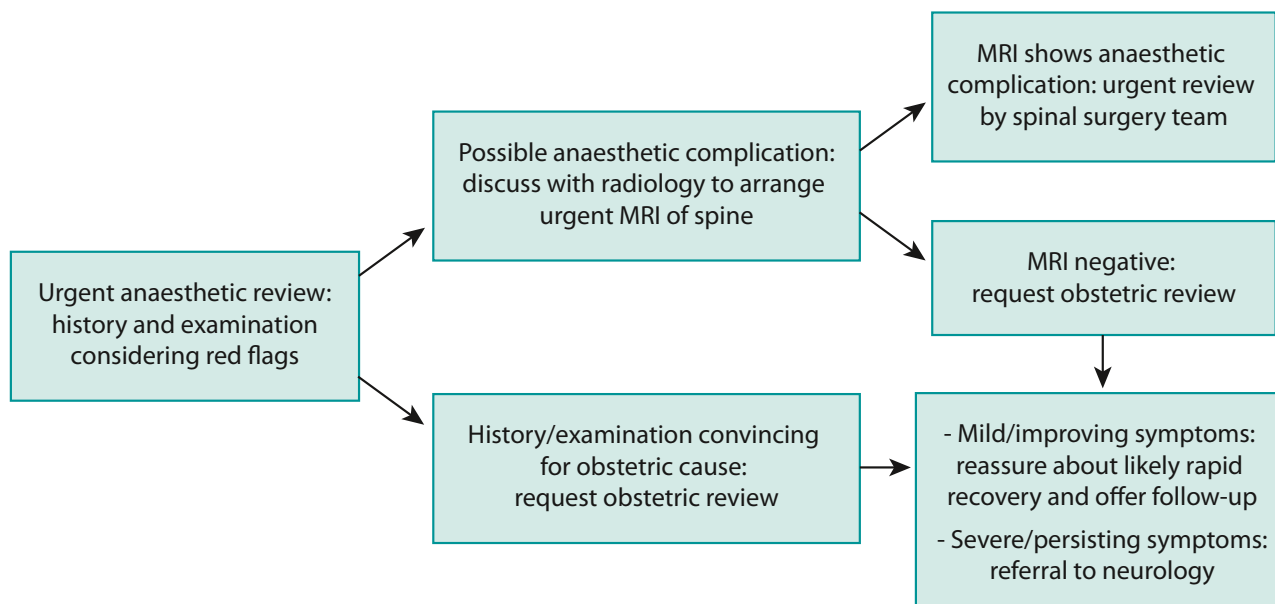


Figure 5. Management of postpartum neurological symptoms. MRI = magnetic resonance imaging.

sensory, motor and autonomic symptoms, including anal and bladder sphincter involvement and paraplegia, which may be permanent.

Investigation of postpartum neurological symptoms

A key step in managing neurological symptoms on the postnatal ward is to consider spinal cord and cauda equina lesions¹⁶. Therefore, women who have undergone regional anaesthesia should be reviewed by an anaesthetist to rule out anaesthetic complication (see Figure 5 for a flowchart to guide investigation and management). If anaesthetic complication is thought to be unlikely, this should be followed by an obstetric review. In cases of spinal/epidural haematoma or abscess, irreversible neurological impairment can rapidly occur, so if these are suspected, urgent review and investigation with MRI and neurology/spinal surgery opinion is necessary.

The woman should be asked about current back pain, constitutional symptoms and sensory, motor and sphincter symptoms. Key clinical findings include back pain and bilateral or sphincter symptoms (see Table 1). Details of any pre-existing back pain or neurological symptoms should be ascertained. Neurological examination should be carried out to accurately delineate the degree of motor, sensory and sphincter impairment. Unilateral sensory or motor impairment without back pain, which occurs in a distribution related to one of the commonly affected nerves

(Figure 4), is reassuring. Such symptoms suggest nerve damage in a peripheral nerve; in other words, an obstetric cause. A confident diagnosis of the problem can often be made, backed up with nerve conduction studies if the clinician is unsure or if the symptoms are prolonged.

Isolated postpartum back pain is common and most often has musculoskeletal causes. Patients can be reassured that their regional anaesthetic is unlikely to have caused the problem.²³ However, back pain and tenderness associated with neurological symptoms must be investigated with urgent MRI of the spine to rule out a central lesion. Haematomata and abscesses cause back pain because of irritation of the posterior rami of the spinal nerves.

As noted above, bilateral symptoms can occasionally be caused by obstetric causes, but are more strongly associated with 'anaesthetic' causes. A spinal canal lesion must be ruled out. Anal and urethral sphincter weakness, caused by stretching of the pelvic floor and damage to the pudendal and autonomic nerves, is common after childbirth. Isolated difficulty with continence/voiding is therefore likely to be obstetric in nature. However, when combined with neurological symptoms and/or back pain, it must be urgently investigated.

Time course may also be a guide. Deteriorating symptoms, or those that appear after a symptom-free interval, suggest a spinal canal lesion (abscesses, especially, tend to have a delayed presentation) and should be urgently investigated. Blood tests can help because raised inflammatory markers may point to epidural abscess as the cause.

Table 1. Red flags requiring consideration of urgent further investigation

| Red flag | Relevance | Notes |
|------------------------|---|--|
| Back pain | Central lesions affect the posterior rami of spinal nerves, causing back pain | Musculoskeletal back pain is common following labour and delivery, whether or not regional anaesthesia is used |
| Bilaterality | Central lesions affect both sides of the spinal cord | Femoral and obturator neuropathy occurs bilaterally in 25% of cases |
| Sphincter symptoms | Central lesions may affect autonomic nerves to sphincters | Pelvic floor and sphincter weakness are common postpartum, even without evident nerve damage |
| Protracted time course | Abscesses present 4–10 days postpartum | |
| Coagulopathy | Spinal/epidural haematoma more common in the presence of coagulopathy | |

Referral to neurology for nerve conduction studies can more precisely delineate the site of a nerve injury – and is needed if the diagnosis is unclear or if symptoms are more severe or prolonged. Nerve conduction studies are not very helpful in the first week after nerve injury. In the acute phase, they cannot determine the severity of injury; even in more severe injuries, the nerve distal to the injury remains electrically excitable until Wallerian degeneration of the neurones has taken place, which takes several days. From around 1 week after nerve injury, nerve conduction studies can usefully be performed to delineate the site of the nerve lesion and distinguish neurapraxia and axonotmesis, thereby guiding advice about prognosis and treatment.²⁴ If, in the first week, severe symptoms suggest axonotmesis or neurotmesis, MRI is the most useful investigation.

Treatment of obstetric nerve injuries

If an obstetric neurological injury has occurred, explanation of the cause of the problem and reassurance are usually all that is necessary: most obstetric nerve injuries resolve completely within 3 months.²¹ However, some injuries may be missed in the early postnatal period and some may persist.²⁵ In the case of a more profound or long-lasting deficit, referral to a neurologist and physiotherapist is recommended. Continuing treatment will depend on clinical history and examination, combined with nerve conduction studies to determine the site and severity of nerve damage. Treatment for specific nerve injuries is discussed above and is summarised in Table 2.

Prevention of obstetric nerve injuries

It is important to prevent neurological injuries, and measures should aim to reduce the duration and severity of

Table 2. Treatment of nerve injuries

| Treatment type | Treatment options |
|----------------|--|
| Conservative | Advice and reassurance of the good prognosis for mild injuries Physiotherapy to guide; e.g. exercise therapy for motor nerve injuries Support braces; e.g. for foot drop/knee support |
| Medical | Medications for neuropathic pain that are safe in breastfeeding include paracetamol, nonsteroidal anti-inflammatory drugs (not high dose aspirin), amitriptyline and gabapentin. There are limited data for pregabalin, which is therefore best avoided |
| Surgical | Nerve grafting (for severe nerve injuries; e.g. nerve transection) |

compression of the pelvic and leg nerves. Practical methods to reduce the risk of nerve injuries include:

- Only putting patients into the lithotomy position immediately before surgery, after ‘time out’ (more than 2 hours in lithotomy is associated with increasing risk of injury)¹³
- Helping women to change position frequently during labour and delivery – especially avoiding prolonged thigh flexion
- Using lower dose epidurals to allow ambulation and increase women’s awareness of impending nerve injury (for example, the onset of pain/paraesthesia)
- Ensuring timely intervention in obstructed labour

- Treating shock in a timely fashion to maintain blood pressure and therefore perfusion to the spinal cord and peripheral nerves.

Global health perspective

Long-term neurological injuries following childbirth are rare in the UK. Obstetricians observing uncommon and transitory neurological injuries may therefore be forgiven for thinking these injuries are a minor problem. However, if women in the UK occasionally develop nerve damage from a long labour, then women in settings without access to safe obstetric services, who may remain in labour for days, will be at higher risk.²⁶ Obstetric fistula has received the most attention in the medical and popular press, but it is just one part of a spectrum of injuries resulting from neglected obstructed labour. The short-term and long-term consequences, termed the 'obstructed labour injury complex', include fetal death, ruptured uterus, obstetric fistula, anal sphincter incompetence, secondary infertility and social and psychological trauma.²⁷

Acknowledging obstetric neurological injuries as a marker for prolonged pressure effects in the pelvis should alert the UK-based obstetrician to look out for other sequelae of prolonged labour. However, from a global health perspective, awareness of the entirely preventable obstructed labour injury complex must remind us of our responsibilities to global women's health. The underlying cause of a woman experiencing foot drop following a long labour could be considered a failure of national and international policy to prioritise women's health, including access to safe caesarean section to treat obstructed labour.

Conclusion

Neurological injuries are an occasional presentation on UK labour and postnatal wards, although prospective series suggest mild injuries may occur in up to 2% of parturients. They can be disabling and distressing to our patients but, fortunately, are only rarely associated with long-term deficit. While causes related to obstetric anaesthesia must be urgently considered and excluded, most cases have intrinsic obstetric causes. From a global health perspective, obstetric nerve injuries are part of the obstructed labour complex of injuries and are a persistent problem in areas of the world in which women lack access to skilled labour care and timely caesarean section or instrumental delivery.

Disclosure of interests

There are no conflicts of interest.

Contribution to authorship

SE instigated and edited the article. RH researched and wrote the article. HW and OL wrote and edited the article. All authors approved the final version.

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