Original Article

Obstetric management following traumatic tetraplegia: Case series and literature review

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Objective: Pregnancy in tetraplegia is a rare event, with only sporadic cases reported. This case series describes seven pregnancies in five tetraplegic women, all with spinal cord injuries in the region of C6.

Design: Retrospective case series.

Setting: Sydney, Australia.

Population: All tetraplegic women presenting to the obstetric service of a university teaching hospital, which also provides a regional spinal injury service, between 1981 and 2006.

Methods: Hospital records of all patients were examined and information extracted regarding demographics, pregnancies and their complications, labour and delivery and neonatal data.

Main outcome measures: Course, complications, management and outcomes of pregnancy in tetraplegic women.

Results: Mean age at the time of injury was 22 years, and, at the time of pregnancy, 33 years. All patients suffered recurrent, and sometimes severe, urinary tract infections and episodes of autonomic dysreflexia during pregnancy. Frequent and sometimes lengthy hospital admissions were required for these and other reasons. Only two pregnancies required caesarean section and all entered labour spontaneously, at a mean of 37.9 weeks of gestation. Episodes of autonomic dysreflexia were aggressively managed using pre-emptive epidural anaesthesia and sublingual nifedipine. All pregnancies resulted in normal, near-term babies with no serious perinatal problems.

Conclusions: Pregnancy and childbirth in tetraplegic women can be undertaken safely, usually with spontaneous onset of labour and vaginal delivery. However, hospitalisation for intercurrent problems is common. Management requires a multidisciplinary approach and is best undertaken in major centres with both obstetric and spinal cord injuries medical expertise.

Key words: autonomic dysreflexia, childbirth, labour, pregnancy, quadriplegia, tetraplegia.

Introduction

Pregnancy in tetraplegic patients is a rare event. The population of tetraplegic women of child-bearing age is small and the potential non-obstetric complications of their condition are numerous. The literature worldwide reports only single cases and a few very small case series of pregnancy and delivery in spinal cord injuries at various spinal levels,1 the most recent series published in 19942 and the largest in 1972.3

Obstetric management of tetraplegic patients is influenced by the level and completeness of spinal cord injury (SCI) and individual psychological issues in addition to obstetric and fetal problems. Previously published series list the major complications in these pregnancies as recurrent and severe urinary tract infections (UTI), autonomic dysreflexia and increased risk of preterm labour and delivery.

Tetraplegia in this paper is defined as a SCI above the neurological level of T1. Although patients with lesions below C5 may have some upper limb function and therefore could be strictly defined as tetraparetic rather than tetraplegic, injuries above T1 are associated with increased risks compared with lower spinal cord injuries. Almost all such patients experience autonomic dysreflexia. They have significantly decreased mobility compared with patients with lower lesions. They have decreased respiratory reserve which is further compromised as pregnancy advances. The increased severity of their disability further impacts on their psychosocial and physical situation, requiring increasing support as their pregnancy advances, during their hospitalisation and at discharge.

Autonomic dysreflexia (sometimes called autonomic hyperreflexia) is a syndrome of massive, unbalanced reflex sympathetic discharge occurring in patients with SCI above the splanchnic sympathetic outflow (T5–T6). Below the injury, sensory nerves transmit impulses that stimulate sympathetic...
neurones located in the spinal cord. The large, unopposed sympathetic outflow causes sudden elevation in blood pressure, piloerection, skin pallor, and severe vasoconstriction below the neurological level.

The inhibitory response to this, from cerebral vasomotor centres, causes vasodilation above the level of injury, with pounding headache, flushing, blotching of skin, nasal congestion, nausea, anxiety, malaise, prickling sensation in the skull. Signs include sweating, blushing, piloerection, tremor and nasal obstruction. There may be twitching and increased spasticity in all limbs. Cardiac rhythm disturbances are possible, including extrasystoles, bigeminy, prolonged PR interval and AV block. Cardiac arrest,\textsuperscript{4} retinal haemorrhage, subarachnoid and other forms of intracranial haemorrhage have been reported.\textsuperscript{5}

### Methods

Royal North Shore Hospital, Sydney (RNSH) provides both a statewide SCI service and a large obstetric service. A single obstetrician (KH) was referred all obstetric patients linked to the SCI unit between 1981 and 2006. This paper reports his experience with pregnant tetraplegic patients and constitutes the first such case series reported.

All cases of tetraplegic pregnancy at RNSH were managed by one of the authors (KH) between 1981 and 2006. Medical records were analysed retrospectively both from his private files and the public hospital records. All correspondence, medical and nursing records were assessed. All files were reviewed by the same investigator (ES).

Information collected included details of the spinal cord injuries as well as the pregnancies. Data collected regarding the spinal cord injuries included the neurological level, mechanism of injury and duration of tetraplegia. We also assessed continence and fertility status. We looked at the course and complications of the pregnancies, deliveries and postnatal period. Other data collected regarding the pregnancies included maternal age, number of pregnancies, gestation, fetal presentation and gestation on admission to hospital. Pregnancy complications sought included UTI, autonomic dysreflexia and muscle spasms, deep-vein thrombosis (DVT), skin breakdown and uterine prolapse. Delivery data included method of delivery, the duration of each stage of labour, anaesthesia used, perineal tears and episodes of autonomic dysreflexia, including the maximum blood pressure reached. Outcome assessment included the general health of the mother postnatally and any long-term sequelae of pregnancy, as well as the general health of the babies. We also assessed breastfeeding and any complications. Baby follow-up data included growth parameters, Apgar scores and any interventions received.

### Results

There were five patients and seven pregnancies. One patient acquired her SCI during pregnancy. Five of seven babies were delivered vaginally. Four male and three female infants were born.

Table 1 lists the characteristics of the mothers. All had SCI at C6. Mean age at the time of injury was 22 years (range 13–32). Mean age at the time of pregnancy was 33 years (range 26–38). Admissions ranged from one to three per pregnancy. DVT prophylaxis was only used in the two most recent patients.

Table 2 lists complications that arose during the seven pregnancies. All the tetraplegic mothers developed UTI. Autonomic dysreflexia and increased spasticity occurred in most. The patients required hospital admission from one to three times per pregnancy. Problems arising during pregnancy, labour and the puerperium resulted in protracted periods of inpatient care. Patients spent a mean of 59.4 days in hospital (range 17–166) per pregnancy.

Table 3 lists labour-related data. Only two pregnancies required caesarean section. Mean onset of labour was at 37.9 weeks gestation (range 35–39). For vaginally delivered pregnancies, mean duration of first stage of labour was 4.7 h (range 3.2–7.8), second stage 27.8 min (range 11–30), and third stage six minutes (range three to 13).

Blood pressure data were not available for three pregnancies. For those where data were available, marked hypertension was apparent, reflecting episodes of autonomic dysreflexia. Mean maximum systolic pressure was 192 mmHg (range 160–215), mean maximum diastolic pressure was 117 mmHg (range 90–131).

Table 4 lists basic neonatal data. Despite their complex pregnancies and deliveries, all babies were born in good

### Table 1 Maternal characteristics

<table>
<thead>
<tr>
<th>Level of lesion</th>
<th>Time from injury to pregnancy</th>
<th>Age at pregnancy</th>
<th>Year of parturition</th>
<th>Admissions during pregnancy</th>
<th>DVT prophylaxis</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C5/6 Incomplete</td>
<td>Injury at 21 weeks gestation</td>
<td>32</td>
<td>1987</td>
<td>3</td>
</tr>
<tr>
<td>B1</td>
<td>C6 Complete</td>
<td>18 years</td>
<td>31</td>
<td>1989</td>
<td>2</td>
</tr>
<tr>
<td>B2</td>
<td>C5/6 incomplete</td>
<td>21 years</td>
<td>35</td>
<td>1992</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>C5/6 incomplete</td>
<td>6 years</td>
<td>26</td>
<td>2001</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>C5/6 incomplete</td>
<td>12 years</td>
<td>35</td>
<td>2006</td>
<td>2</td>
</tr>
<tr>
<td>E1</td>
<td>C6/7 incomplete</td>
<td>12 years</td>
<td>34</td>
<td>1996</td>
<td>1</td>
</tr>
<tr>
<td>E2</td>
<td>C6 incomplete</td>
<td>16 years</td>
<td>38</td>
<td>1999</td>
<td>1</td>
</tr>
</tbody>
</table>

DVT, deep-vein thrombosis.
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Table 2 Complications during pregnancy

<table>
<thead>
<tr>
<th>Complications</th>
<th>Preganancies affected</th>
<th>Adverse outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>UTIs</td>
<td>7</td>
<td>Five admissions</td>
</tr>
<tr>
<td>Dysreflexia</td>
<td>6</td>
<td>One precipitated preterm labour at 33 weeks</td>
</tr>
<tr>
<td>Muscle spasms</td>
<td>4</td>
<td>Nil</td>
</tr>
<tr>
<td>Skin breakdown</td>
<td>2</td>
<td>One required a surgical flap months after delivery</td>
</tr>
<tr>
<td>Constipation</td>
<td>2</td>
<td>Nil</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRSA vaginal swab</td>
<td>1</td>
<td>Nil</td>
</tr>
<tr>
<td>Uterine prolapse</td>
<td>1</td>
<td>Nil</td>
</tr>
<tr>
<td>Renal calculi</td>
<td>1</td>
<td>Nil</td>
</tr>
<tr>
<td>Thrush</td>
<td>1</td>
<td>Nil</td>
</tr>
<tr>
<td>Oesophageal reflux</td>
<td>1</td>
<td>Nil</td>
</tr>
<tr>
<td>DVT</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

DVT, deep-vein thrombosis; MRSA, methicillin-resistant *Staphylococcus aureus*; UTI, urinary tract infection.

Discussion

Preterm birth

Obstetric management of tetraplegic patients is an area in which there is little experience or knowledge. The largest case series of spinal cord-injured patients was published in 1972 and pooled retrospective observations of clinicians from 24 countries of 175 cases. This series suggested that there was a risk of preterm labour, as five preterm babies, less than 2500 g, and another three less than 3000 g were born out of 33 pregnancies that proceeded past six months. A review by Pereira in 2003 synthesised the more complete data available from the four more recent case series (1986–1993) and found that preterm birth rates ranged from 6–13%, which is similar to the published rates of preterm labour in the USA (in 1998) of 11% before 37 weeks gestation. However, this issue remains uncertain, with the three series using differing definitions for ‘pre-term’ and the series sizes ranging from only 13 to 49, including spinal cord injuries at all levels. In our series, one infant was born at 35 + 0 weeks as a direct result of maternal septicaemia associated with UTI, which could be directly attributed to her SCI. The remainder were born at or near term.

Epidural anaesthesia and autonomic dysreflexia

Several authors have recommended the use of prolonged epidural anaesthesia to control autonomic dysreflexia in the postpartum period. Epidural anaesthesia has been shown to control autonomic dysreflexia in a tetraplegic patient following general surgery. In a 2004 case report, an epidural infusion of local anaesthetic was maintained for four days after a general surgical procedure. Since tetraplegic patients have been reported to have autonomic dysreflexia for up to five days post-partum, epidural anaesthesia might be considered in patients who have been more susceptible to dysreflexia during pregnancy and may therefore be more susceptible in the postpartum period. In 2006, a case report by Osgood et al. suggested that spinal anaesthesia may be superior to epidural anaesthesia in providing haemodynamic stability against autonomic dysreflexia during caesarean section. Neither spinal nor prolonged epidural anaesthesia was used in our series.

In our case series, autonomic dysreflexia was managed pre-emptively by insertion of an epidural either before or in the early stages of labour. Generally, autonomic dysreflexia was well controlled. Although there were peaks that were dangerously high these were quickly managed by prompt identification of the stimulus and, during labour, by the administration of either sublingual nifedipine or intramuscular clonidine.

In some parts of the world sublingual nifedipine is no longer available. The capsule form was withdrawn from the Australian market in 1997 due to concerns about adverse effects of long-term treatment in patients with heart disease, although nifedipine and hydralazine had been endorsed for use for severe hypertension in pregnancy by the Australasian Society for the Study of Hypertension in Pregnancy. Although clonidine is not approved for use in pregnancy, no adverse effects were experienced in our case. Glyceryl trinitrate is now commonly used by our spinal injury service to treat autonomic dysreflexia in non-pregnant patients. Labetalol and mini-bolus diazoxide have both been recently advocated as safe and effective alternatives to hydralazine for acute hypertension in pregnancy. All these medications have the potential to cause acute hypotension that could affect fetal blood flow.

Figure 1 demonstrates the typical pattern of autonomic dysreflexia in patient D. The graph also suggests a beneficial
### Table 3 Labour data

<table>
<thead>
<tr>
<th>Patient (Pregnancy)</th>
<th>Maternal parity</th>
<th>Delivery</th>
<th>Gestation weeks + days</th>
<th>Labour stage</th>
<th>Complications</th>
<th>Epidural</th>
<th>Management of AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>P1G0</td>
<td>Vaginal + forceps</td>
<td>39 + 1</td>
<td>7 h and 45 min</td>
<td>1 h and 6 min</td>
<td>2°</td>
<td>Delayed second stage.</td>
</tr>
<tr>
<td>B(1)</td>
<td>P1G0</td>
<td>Vaginal</td>
<td>38 + 4</td>
<td>4 h and 15 min</td>
<td>30 min</td>
<td>5 min</td>
<td>Episiotomy</td>
</tr>
<tr>
<td>B(2)</td>
<td>P2G1</td>
<td>Vaginal</td>
<td>35 + 0</td>
<td>3 h and 30 min</td>
<td>18 min</td>
<td>3 min</td>
<td>Episiotomy</td>
</tr>
<tr>
<td>C</td>
<td>P1G0</td>
<td>Emergency LSCS for fetal distress</td>
<td>38 + 0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>D</td>
<td>P2G0</td>
<td>Vaginal + low ventouse</td>
<td>38 + 5</td>
<td>5 h and 0 min</td>
<td>11 min</td>
<td>13 min</td>
<td>2°</td>
</tr>
<tr>
<td>E(1)</td>
<td>P1G0</td>
<td>Vaginal + low ventouse</td>
<td>38 + 2</td>
<td>3 h and 10 min</td>
<td>20 min</td>
<td>3 min</td>
<td>Episiotomy</td>
</tr>
<tr>
<td>E(2)</td>
<td>P2G1</td>
<td>Emergency LSCS for malpresentation + forceps to aftercoming head</td>
<td>37 + 5</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

AD, autonomic dysrelexia; BP, blood pressure; IM, intramuscular; LSCS, lower segment caesarean section; NA, not applicable; ROM, rupture of membrane; SL, sublingual.
effect in reducing blood pressure of delivery of the baby and then the placenta. Given our favourable experience and the known potential for serious adverse outcomes from autonomic dysreflexia, we recommend close monitoring and early, aggressive treatment of hypertensive episodes.

**Urinary tract infection**

All seven pregnancies in this series were complicated by multiple and severe UTIs. For three of the pregnancies this resulted in hospital admission for the remainder of the pregnancy. One UTI, complicated by sepsicaemia, precipitated preterm labour at 33 weeks and was almost certainly responsible for the premature birth at 35 + 0 weeks. Several infected patients experienced multiple blockages of their suprapubic catheters due to excessive urinary sediment. All were treated with intravenous antibiotics, usually ceftriaxone. One patient had recurrent UTIs caused by various organisms. She was placed on rotating antibiotics for the remainder of her first pregnancy and the entirety of the next one. Cephalexin, amoxycillin and sulfamethoxazole were rotated weekly. This patient was never admitted for severe UTI.

**Coordination of care**

A low threshold for hospital admission is generally advisable. As discussed above, tetraplegic women may be susceptible to premature labour and one infant in this series of 7 was born mildly premature at 35 weeks gestation. Because of decreased or absent sensation, labour may go undetected by the patient, so regular monitoring of uterine tone and cervical dilation and effacement is important. As pregnancy continues, the frequency of episodes of dysreflexia increases. Monitoring of blood pressure and prompt management prevents adverse sequelae. Autonomic dysreflexia may also affect the uteroplacental blood flow, so careful clinical and electronic monitoring of the fetus is also recommended when dysreflexia is severe or frequent.

As with the care of other complex patients, the involvement of many different medical and allied health subspecialties is important. Experts involved in the care of our patients included obstetricians, spinal rehabilitation physicians, anaesthetists, nurses, physiotherapists, occupational therapists, lactation consultants, paediatricians and neonatologists as well as many others. Cohesive multidisciplinary team function is essential, and we recommend that these patients be managed, where possible, in centres where expertise in spinal cord injuries and obstetrics coexists.

Careful pregnancy planning is also recommended. All tetraplegic patients have complex medical problems prepregnancy. Management of medications is a potential difficulty, with so many of the less-commonly used drugs untested for possible teratogenicity and other adverse effects. The goal of optimising the medical management of the mother while minimising the potential risks to the fetus can be a difficult juggling act, requiring much research and expert advice.
Other issues
In 1991, a case series of 16 spinal cord-injured patients was published,1 ‘about half tetraplegia’. These authors identified an increased risk of complications such as abnormal presentation and failure to progress. These features were not noted in our series.

Other significant observations have included autonomic dysreflexia as a sign of uterine contractions in preterm labour,22 the importance of using non-absorbable sutures in episiotomy closure in denervated areas due to an increased risk of sterile abscess and wound dehiscence,23 as well as noting that caesarean section in the presence of a permanent suprapubic catheter may dictate a classical surgical incision.3

Although none of the patients in this series had a DVT during their pregnancy and most did not have prophylaxis, the use of elastic stockings, calf compression devices, unfractionated or low-molecular-weight heparin would be worth considering. In the setting of acute SCI occurring during pregnancy their use is certainly advocated.

Not surprisingly, all of our patients experienced some difficulties with breast feeding, as a result of autonomic dysreflexia, inhibition of the milk ejection reflex due to the underlying neurological lesion, and problems of infant handling. Paradoxically, patient B, who had a clinically complete cord lesion at C6, had minimal difficulties with breast feeding.

Our experience builds on that of previous authors. Tetraplegic patients can expect to have good outcomes when considering pregnancy. They deliver well vaginally, as all did in our series. The high spinal cord lesions in our series necessitated more instrumental deliveries than previous series involving a broader range of spinal cord lesions.6 The most common complications of pregnancy are complicated and recurrent UTIs and autonomic dysreflexia. However, it is important to be aware of the other problems experienced by these patients, including muscle spasms, uterine prolapse, skin breakdown and increased constipation, as well as the possible risk of premature labour. In planning for care during pregnancy, it is useful to be aware of the increased length and incidence of admissions, the importance of a multidisciplinary approach and careful planning for the potential psychosocial difficulties the patients will face with their babies at home.

Conclusion
Our experience suggests that pregnancy and childbirth in tetraplegic patients can be undertaken safely if care is provided by a multidisciplinary team and ideally in a tertiary referral hospital. The most common problems in our patients were frequent and recurrent UTIs and autonomic dysreflexia. In contrast to previous reports, only one of our patients entered labour prematurely. However, all were admitted to hospital early, partly to facilitate the detection of premature labour. The majority of patients delivered vaginally, but all of these required assistance with forceps or the vacuum extractor. All caesarean sections were done for obstetric indications unrelated to tetraplegia.

Acknowledgements
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Ethics approval
This study was approved by the Ethics Committee of the Northern Sydney Central Coast Area Health Service (Protocol number 0606-091M).

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