Anaesthesia
Journal of the Association of Anaesthetists of Great Britain and Ireland

Anaesthesia, 2010, **65**, pages 664–669 doi:10.1111/j.1365-2044.2010.06368.x

ORIGINAL ARTICLE

Rapid sequence spinal anaesthesia for category-1 urgency caesarean section: a case series

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Summary

General anaesthesia is the fastest method for anaesthetising a category-1 caesarean section but is associated with increased maternal morbidity and mortality. We describe the 'rapid sequence spinal' to minimise anaesthetic time. This consists of a no-touch spinal technique, consideration of omission of the spinal opioid, limiting spinal attempts, allowing the start of surgery before full establishment of the spinal block, and being prepared for conversion to general anaesthesia if there are delays or problems. We present a case series of 25 rapid sequence spinal anaesthetics for category-1 caesarean section. The mean (SD [range]) decision-delivery interval was 23 (6 [14–41]) min. After excluding cases where there was an identified delay, the median (IQR [range]) time to prepare and perform the spinal was 2 (2–3 [1–7]) min, and time to develop a 'satisfactory' block was 4 (3–5 [2–7]) min. The total time to induce spinal anaesthesia was 8 (7–8 [6–8]) min. There were three pre-operative conversions to general anaesthesia and three women had pain during surgery that did not require treatment. Our data indicate that one might expect to establish anaesthesia in 6–8 min using a rapid sequence spinal. Careful case selection is crucial. While rapid anaesthesia is important, the reduction of the decision-delivery interval also requires attention to other stages in the pre-operative process.

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Accepted: 23 March 2010

Regional anaesthesia is preferred in obstetrics because it is safer than general anaesthesia, especially for emergency (categories 1–3) caesarean section [1, 2]. However, because of time constraints, general anaesthesia is used disproportionately for category-1 caesarean sections (immediate threat to life of woman or fetus) [2]. If spinal anaesthesia can be performed faster, it becomes a more acceptable option.

We described a new approach to the provision of spinal anaesthesia for the most urgent obstetric cases in 2003 [3]. The principles include use of a no-touch technique for spinal insertion, simplifying the spinal drug combination, limiting the permitted time available for insertion attempts, if necessary starting the surgery before full establishment of the block, and making preparations to administer general anaesthesia in the event of spinal failure (Box 1 modified from reference [4]). We report our experience with this approach together with some illustrative case reports.

Box 1: Components of the rapid sequence spinal (adapted from reference [4])

- Deploy other staff for intravenous cannulation and monitoring – don't inject spinal till cannula secured.
- Pre-oxygenate during attempt.
- 'No touch' technique – gloves only with glove packet as sterile surface for equipment. Skin prepared with single wipe of 0.5% chlorhexidine solution.
- If no opioid – consider increased dose hyperbaric bupivacaine 0.5% (up to 3 ml); add fentanyl 25 μg if procuring it does not produce unacceptable delay.
- Local infiltration not mandatory.
- One attempt at spinal unless obvious correction allows a second.
- If necessary start surgery when block ≥ T10 and ascending. Be prepared to convert to general anaesthesia – keep mother informed.

Case 1

A para-4 woman was admitted to the labour ward at 33 weeks' gestation with a history of intermittent suprapubic pain and tenderness and a small vaginal bleed. The fetal heart rate trace showed a baseline rate of 180 beats.min^{-1}, reduced variability and variable decelerations in response to weak uterine contractions. This progressed to a persistent fetal bradycardia. Intra-uterine resuscitation was started, including subcutaneous terbutaline 250 μg and oxygen 10 l.min^{-1} from a Hudson mask with reservoir bag [5]. She was taken to the operating theatre in the left lateral position. The obstetric junior trainee sited an intravenous cannula while the anaesthetist prepared the spinal equipment. Following skin preparation with a solution of 0.5% chlorhexidine in alcohol, a 25-G Whitacre spinal needle was inserted with a no-touch technique and 2.8 ml hyperbaric bupivacaine 0.5% was injected 3 min after arrival in the operating theatre, following which the woman was turned supine with left lateral table tilt for surgery. The upper level of the spinal block to no cold using ethyl chloride was T5 bilaterally 3 min after the spinal injection, and the baby was delivered by caesarean section 4 min later in good condition, though she was admitted to the neonatal intensive care unit for 9 days because of prematurity, intra-uterine growth restriction and hypoglycaemia. The decision-delivery interval was 19 min.

Case 2

A nulliparous woman with a twin pregnancy had a cord prolapse at home at 33 weeks' gestation. The ambulance crew arrived at her home 22 min later and telephoned a message through to the Delivery Suite. While waiting for the woman to arrive in the hospital, the anaesthetist prepared the equipment for the spinal, including 2.4 ml hyperbaric bupivacaine 0.5% with diamorphine 300 μg, using an aseptic technique. The patient was brought directly into the operating theatre by the ambulance crew 18 min after their call where all the team members were waiting. She was given oxygen. The presence of fetal heartbeats was assessed with ultrasound, and surgical and anaesthetic consent gained while intravenous cannulation was performed and monitoring applied. A rapid sequence spinal using a 25-G Whitacre needle was performed 5 min after arrival in the hospital, after which she was placed supine with left lateral pelvic tilt using a wedge cushion for surgery. Head-down table tilt was applied to speed the cephalad spread of the block. Four minutes later, a T7 block to cold was recorded. Caesarean section started 1 min later and the first twin was delivered after a further 3 min, 31 min after the first alert and 13 min after arrival. This was 53 min after the cord prolapse. The spinal block level at delivery was recorded at T3.

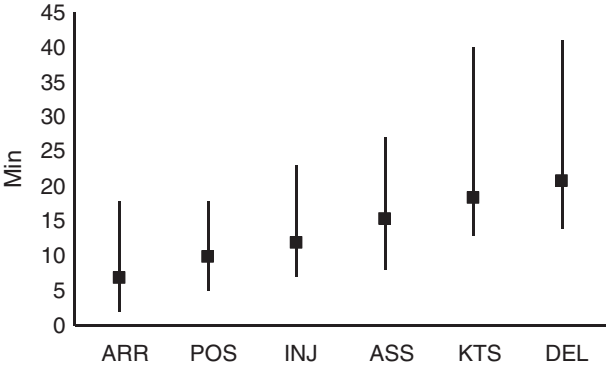

Figure 1 Times to achieve steps from decision for delivery (time 0) until delivery. Median [range] in minutes shown for each step. ARR, arrival in operating theatre; POS, woman positioned, start of spinal; INJ, spinal injection (or abandonment of attempts); ASS, block assessed as adequate; KTS, start of surgery (knife to skin); DEL, delivery.

Both twins were born in good condition, although the second twin subsequently required continuous positive airway pressure on the neonatal unit for 3 days.

Summary of 25 cases

We have reviewed the management of 25 'rapid sequence spinals' for caesarean section carried out in our unit. The indication for surgery in 22 cases was severe fetal compromise diagnosed by abnormal fetal heart rate pattern. The other three cases had umbilical cord prolapse. The mean (SD [range]) weight of the women was 66.4 (13.7 [47–114]) kg, and the BMI was 25.0 (5.5 [18–44]) kg.m^{-2}. Eight women were parous, of whom four were grand multipara. The position used for spinal insertion was left lateral in 17, right lateral in seven and sitting in one. The mean (SD) volume of spinal hyperbaric bupivacaine 0.5% was 2.6 (0.33) ml. Fentanyl was added in six cases, in doses between 15 μg and 25 μg, and diamorphine 300 μg was added in two cases. The median (IQR [range]) block heights to no-cold [6] that were deemed to indicate an 'acceptable' block for the start of surgery were T4 (T4–T5 [T1–T10]).

Decision time was taken as the earliest time that an obstetric decision to transfer to the operating theatre for delivery, possibly by caesarean section, was recorded. The final confirmation of the decision for caesarean section was made by vaginal examination in the operating theatre in eight cases and after a failed forceps delivery in one. The mean (SD [range]) decision-delivery interval was 22.5 (5.9 [14–41]) min (Fig. 1). Three cases had a decision-delivery interval of >30 min; case 2 which took

31 min was not in hospital when the alert was first given, a case of failed forceps took 41 min, and a case that was converted to general anaesthesia took 33 min.

In three cases, the spinal space could not be located and general anaesthesia was performed. The decision-delivery intervals for these three cases were 16, 20 and 33 min. There were three cases of discomfort or pain that did not require treatment. The first, with a T8 block on testing before surgery, had discomfort on stretching the rectus sheath. The second had pain on incising the peritoneum, but surgery was paused for a minute and then continued with no further pain. The block height before starting was not recorded. The third case, with a T4 block at the start, had shoulder tip pain towards the end of surgery.

After excluding cases where there was an identified delay, the median (IQR [range]) time from positioning for spinal anaesthesia and starting to prepare the equipment until spinal injection was 2 (2–3 [1–7]) min (n = 9). After excluding cases with delays as well as those who had a prior epidural block, the median (IQR [range]) time from injection until assessment of a satisfactory block was 4 (3–5 [2–7]) min (n = 11). The median (IQR [range]) total time for anaesthesia after exclusions was 8 (7–8 [6–8]) min (n = 6).

Sixteen cases had subcutaneous terbutaline 250 μg for tocolysis, with varying degrees of resolution of the fetal heart rate abnormality. The median (IQR [range]) 1- and 5-min Apgar scores were 9 (7–9 [1–10]) and 10 (9–10 [3–10]), respectively. The mean (SD) umbilical artery and vein pH were 7.21 (0.08) and 7.28 (0.08), respectively. Eight of the 26 neonates had an Apgar score of ≤ 7 at 1 min and nine had an umbilical artery pH < 7.20, though only five neonates fitted both criteria.

In two other cases that are not included here, a rapid sequence spinal was performed after which a successful assisted vaginal delivery was carried out. In one case, fetal bradycardia occurred and vaginal examination in the labour room found an 8-cm dilated cervix. She was transferred to the operating theatre, the spinal injection was performed 5 min after the decision for delivery and a satisfactory block of T6 was recorded after a further 5 min. However, when the fetal monitoring was reapplied in the operating theatre, the fetal heart rate pattern had returned to normal, 7 min after the decision and 11 min after intrauterine fetal resuscitation including terbutaline. A ventouse was applied 28 min after the decision and the baby was delivered 37 min after the decision.

Discussion

Regional anaesthesia is promoted in obstetric practice for reasons of safety. Most women also wish to be awake for caesarean section [7], and anaesthetists try to comply with this whenever possible [8]. However, multiple or prolonged attempts at spinal anaesthesia have been implicated as a cause of long decision-delivery interval [9] as well as adverse neonatal outcome [10].

We use the term 'rapid sequence spinal' to encapsulate the idea of performing a spinal anaesthetic with the bare essentials while emphasising the importance of limiting the number of attempts at insertion [4]. The use of the term 'rapid sequence' derives from emergency general anaesthesia, and currently implies both the speed of induction as well as the importance of abandoning intubation in favour of alternative oxygenation techniques at an early stage. The same principle should be applied when attempting a rapid sequence spinal such that attempts are abandoned just as quickly in favour of the alternative anaesthetic technique. While not specifying a time limit per se, we teach the importance of abandoning the spinal attempt with the same speed as abandoning intubation in a failed rapid sequence induction. The consent and information process is extremely brief, with the aim of establishing that the woman prefers regional anaesthesia, that there are no contra-indications to spinal anaesthesia and that general anaesthesia will be used if there are any delays in establishing adequate surgical anaesthesia with the spinal.

We have examined the different factors involved in preparation, insertion and establishment of spinal anaesthesia to determine which could be modified or dispensed with for the most urgent case. The recommended standard of practice in the UK for epidural catheterisation is to perform a full aseptic technique with hand washing, sterile gloves, sterile gown, hat, mask, antiseptic skin preparation and sterile drapes [11]. In a postal survey, gown, gloves, hat and mask are worn by 73% of UK obstetric anaesthetists when performing a spinal [12]. For the rapid sequence spinal, we suggest the use of a no-touch technique for spinal insertion with sterile gloves but not a gown. Practice differs in other countries [13], and our recommendation for rapid sequence spinal is similar to routine practice in Holland [14].

We advise using the most convenient position for inserting the spinal, based on obstetric factors as well as the anaesthetist's preference. However, the sitting position, commonly used for spinal insertion, may make the fetal condition worse. The left lateral position is usually best for uterine blood flow in the presence of fetal compromise [5] and the knee-elbow position or left lateral with head down tilt is recommended for cord prolapse [15]. The lateral position, which is the routine for spinal anaesthesia for category-4 (elective) caesarean section in our hospital [2], was used for all but one of our cases. It is notable that only two of these women were obese (BMI > 30 kg.m^{-2}). Once the spinal injection has

been performed, the woman is immediately turned into the supine position with lateral table or pelvic tilt and maintained like this until delivery. It is a consistent finding that spinal block for caesarean section develops more quickly in the supine position with lateral tilt compared to the lateral position [16–18].

The use of a lipophilic opioid in the injectate reduces the risk of pain during caesarean section [19]. Opioids in the UK are kept in a locked drug cupboard and the key is held by another professional other than the anaesthetist. Diamorphine 300–400 μg is recommended for use in spinal anaesthesia for caesarean section as it provides prolonged postoperative analgesia [19]. However, most hospitals do not have a low-dose preparation and therefore the dose has to be taken out of a 5- or 10-mg ampoule after reconstitution from powder, which takes time. We suggest for rapid sequence spinal that fentanyl (50 $\mu g.ml^{-1}$) is used, as no dilution is required. However, if there any delay in accessing fentanyl then the anaesthetist should use bupivacaine on its own, possibly in a higher dose than standard [20].

In three of our cases spinal anaesthesia was performed in the presence of an epidural that had been used for labour. Spinal injection volumes of 1.5, 2.0 and 2.5 ml hyperbaric bupivacaine 0.5% gave block heights of T4, T4 and T10, respectively. When using a spinal after an epidural, best practice may be a low-dose combined spinal-epidural because of the risk of high block with standard spinal doses [21], but this is not possible in the timeframe needed in a category-1 caesarean section. In these three cases, a normal or scaled down spinal dose was not associated with problems.

A recent study of category-4 (elective) caesarean sections found that general anaesthesia took a mean of 4.5 min to induce, whereas spinal anaesthesia took a mean of 8.1 min from the start of decontamination of the back [22]. The time needed to induce regional or general anaesthesia at emergency (categories 1–3) caesarean section is difficult to establish from the literature, as the urgency may not be comparable between studies. An observational study of 'emergency/urgent' caesarean section showed a mean of 5 min from donning gloves to positioning the patient after the spinal injection [23]. Gunka and Douglas timed anaesthesia administration for simulated 'stat' caesarean section and found minimal difference between general anaesthetic induction and spinal injection, with a mean time of 2 min 6 s for the former and 1 min 58 s for the latter. However, none of the simulated spinals were difficult [24]. Consistent with this study, the median period for starting spinal preparations until spinal injection in our series was 2 min.

Three of 25 (12%) cases were converted to general anaesthesia because of failure to locate the spinal. This compares to an overall conversion rate of 8.4% in all category-1 caesarean sections with spinal anaesthesia in our unit [2]. Overall, the decision-delivery interval was similar for successful or failed spinals, in spite of an unadvised 10-min period from starting the spinal until its abandonment in one of the cases of failure.

There are a number of recommendations for how to determine a satisfactory block before caesarean section, and national practice varies considerably [25]. Though loss of cold sensation to T4 is used most commonly, an argument has been made for a more rigorous but more reliable standard of loss of all touch sensation to T5 (or T6 if using neuraxial opioid) [26]. The reason for this is to block afferent input from intraperitoneal viscera that are manipulated after delivery. However, in the situation of a rising and developing block, surgery can be paused after delivery to allow anaesthesia to intensify. For rapid sequence spinal, we advise starting surgery before a standard block is achieved, balancing the risks of pain or general anaesthetic conversion against the certainty of general anaesthetic risks if the spinal is not attempted. There were two cases of segmental discomfort or pain not requiring treatment; in one case, surgery was delayed for a short while. Both of these had only a short time for the block to develop; in one, surgery was started 2 min after spinal injection and the other 6 min after starting spinal preparation. One further case with a T4 starting block had shoulder tip pain towards the end of surgery. Referred diaphragmatic pain occurs occasionally during caesarean section even with a 'standard' block.

The mean time to achieve a spinal block up to T4 using cold or pinprick at caesarean section has been found to vary between 4 and 12 min [24, 27]. For the rapid sequence spinal, we suggest being prepared to start surgery if the block has reached T10 to cold. After excluding cases with a pre-existing epidural block, the median time from injection until the block was ready for surgery of 4 min was consistent with the quicker published times. Cases with a block onset time of > 4 min all had a T5 block or higher, suggesting that surgery might have been started earlier if it had been required.

Some cases were delayed by vaginal examination performed to reassess cervical dilation. We would argue that the use of intrauterine resuscitation [5] and reassessment of the need for category-1 caesarean section on arrival in the operating theatre is appropriate in many cases, as there are no good data to suggest that reducing the decision-delivery interval below 15 min is beneficial overall [28]. A subgroup of category-1 cases that are likely to have a poor fetal outcome if the decision-delivery interval is more than 15–20 min include placental abruption, fetal haemorrhage, cord prolapse with preterm infant and uterine dehiscence with fetal extrusion [29–32];

general anaesthesia is likely to be necessary to achieve this decision-delivery interval. Although the median time from starting spinal preparations until achieving an adequate block in this series was 8 min and therefore slower than general anaesthesia, in most cases fetal heart rate abnormalities had partly or completely recovered.

We attach provisos to the use of a rapid sequence spinal in our hospital. The possible risks attached to this technique have to be carefully weighed against those of rushed general anaesthesia. We would not recommend it for use by novice practitioners of spinal anaesthesia, as it is preferable that they concentrate on providing one well-administered anaesthetic, which by default is general anaesthesia. It should also not be used for cases where the spinal is predicted to be difficult, unless there are also specific factors imparting a high risk of general anaesthesia. If the trainee considered the risk of general anaesthesia to be significantly high, for example in a woman with morbid obesity, the balance of risks might favour further attempts at spinal anaesthesia, particularly while waiting for the arrival of senior help.

In summary, we present a case series of rapid sequence spinal anaesthesia for selected category-1 caesarean sections. Nerve block that was adequate to start surgery was established in 6–8 min. It is important to note that reduction of decision-delivery interval requires effective teamwork [33] and attention to the processes occurring before and after the establishment of anaesthesia.

Acknowledgements

We would like to thank the women described in the two case reports for their permission to publish the details of their cases, as well as the anaesthetists who collected data and Dr Anoo Jain for providing neonatal data. No external funding and no competing interests declared.

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