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Original Research

The time to perform spinal or general anaesthesia in COVID-19 positive parturients requiring emergency caesarean delivery: a prospective crossover simulation study

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Background: Spinal anaesthesia is the commonest performed technique for caesarean deliveries except in the emergency setting where general anaesthesia is preferred due to its rapid onset and predictability. There are several modifications to performing general anaesthesia for COVID-19 patients in Australia. We hypothesised that the performance time of these techniques amongst specialist anaesthetists would be similar for COVID-19 parturients undergoing emergency caesarean delivery. *Methods*: We designed a simulation cross-over study. The primary outcome was the time taken to perform general anaesthesia or spinal anaesthesia in this setting. We also examined the decision-making process time, the decision to incision time and the level of stress associated with both scenarios. *Results*: Nine specialist anaesthetists participated in the research. There was no difference in the time taken to perform spinal or general anaesthesia (mean difference (GA–SA scenario) –1.2 (–5.3–2.8) minutes, $p = 0.5$). Irrespective of group allocation the mean time to complete the spinal anaesthesia scenario was 27.4 (standard deviation = 7.8) minutes, while for the general anaesthesia scenario was 24.0 (7.2) minutes. There was no difference between these times (mean difference (GA–SA scenario) = –3.5 minutes, 95th percent confidence interval –9.7–2.8 minutes, $p = 0.24$). There was no evidence of a carryover effect for the two scenarios based on the group allocation ($p = 0.69$) and no significant difference between stress levels ($p = 0.44$). *Conclusions*: The time to perform spinal anaesthesia was similar to the time to perform general anaesthesia for a confirmed COVID-19 parturient in a simulation environment.

Keywords

Pregnancy; Emergency caesarean delivery; Coronavirus; General anaesthesia for caesarean; Spinal anaesthesia

1. Introduction

The Severe Acute Respiratory Syndrome-Coronavirus-2 (SARS-CoV-2) is the pathogen which causes the clinical respiratory illness known as COVID-19 [1]. Patients with both suspected and confirmed COVID-19 infections pose a number of challenges to the anaesthetist, especially in complex situations such as the provision of anaesthesia when there is an immediate threat to the life of the woman or foetus (emergency caesarean delivery category-1). The acuity and unfamiliarity with the infection control precautions which come with this scenario leads to the potential for increased harm to the treating clinician, the parturient and her foetus.

General anaesthesia has been used frequently for emergency caesarean deliveries category-1 (CAT-1 CD) [2]. The rationale behind these recommendations is that general anaesthesia provides predictable and prompt anaesthesia leading to a faster delivery of the foetus. A shorter decision-to-delivery time interval, or decision to incision time, is considered a surrogate marker of both maternal and foetal outcomes [3]. The decision-to-delivery interval is composed of the times to transfer the pregnant patient to the operating room when the decision for caesarean delivery is made, the anaesthetic technique performance time, the surgical readiness (incision time) and the delivery of the foetus.

For parturients presenting with suspected or confirmed COVID-19, regional anaesthesia should strongly be considered for numerous reasons. Firstly, the preparation and induction for general anaesthesia in these patients requires modifications to standard practice which can substantially increase the decision-to-delivery interval [4]. This includes the use of personnel protective equipment (PPE) to protect staff from virus exposure during induction and intubation of anaesthesia that is considered an aerosol generating procedure (AGP). Spinal anaesthesia avoids airway manipulation and may decrease the risk of viral exposure and staff contamination. Exposure to greater viral loads through airway manipulation, including intubation and extubation, may be associated with a more severe illness and the major mode of human-to-human transmission has been identified as droplets and direct contact [5–7]. Both bag mask ventilation and endotracheal intubation are considered AGPs

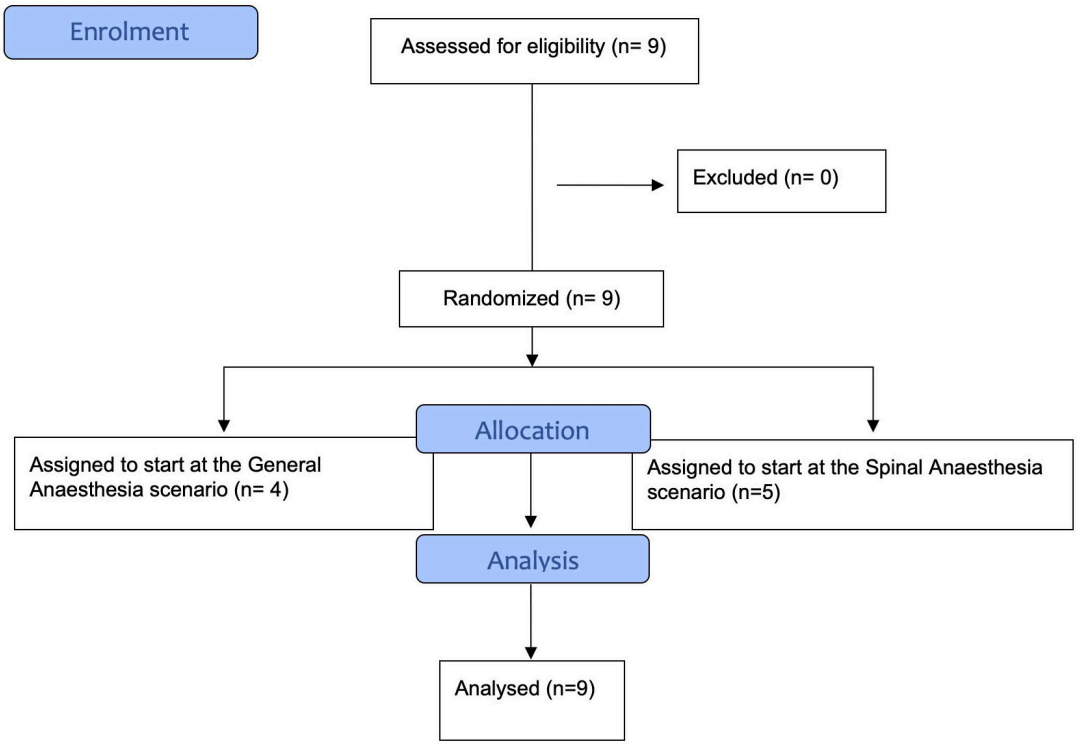

Fig. 1. CONSORT (Consolidated Standards of Reporting Trials) participant flow. Flow diagram illustrating participant enrolment and allocation treatment.

and therefore, present a high-risk scenario for transmission to the airway manager, the staff in the operating room and the neonate. Finally, patients with respiratory infections are more likely to have intraoperative and postoperative complications and benefit from the avoidance of airway manipulation [8].

We hypothesise that in a high-fidelity simulation environment the time to perform either general or spinal anaesthesia amongst specialist anaesthetists in patients with confirmed COVID-19 disease requiring emergency CAT-1 CD would be similar. We also examined the operating room preparation time as a surrogate of the decision-making process; the decision-to-incision time and the level of stress associated with both scenarios.

2. Methods

This study was prospectively approved by the Townsville Hospital and Health Service Human Research Ethics Committee (HREC/QTHS/63914) and was registered on the Australian and New Zealand Clinical Trials Registry (ANZCTR - ACTRN12620000579998). Informed written consent was obtained from the nine specialist anaesthetists who participated in the study. The trial was performed according to the Declaration of Helsinki. Our study complies with the Consolidated Standards of Reporting Trials (CONSORT) guidelines (CONSORT Checklist); a CONSORT flow chart is presented in Fig. 1.

We only included specialist anaesthetists working at the Mackay Base Hospital in Queensland, Australia in order to avoid any bias of experience performing both techniques. All participants were regularly training in simulation the management of general anaesthesia for non-obstetric patients and the management of spinal anaesthesia for non-obstetric emergencies in patients with confirmed or suspected COVID-19 disease as per institution simulation protocols. There was no other regular simulation training in the hospital such as management of category-1 caesarean delivery. The team of staff specialist is small (9 specialists) and given the novelty of PPE application and the evolving COVID-19 situation at the time of study design, it was unclear how long this process would take, as such we were unsure as to which values to used when performing an a priori power calculation and the decision was to include all staff specialists willing to participate in the study. If informed consent was unable to be obtained, a potential participant was excluded from study participation. The study utilised a crossover design where participants were randomly assigned to a sequence of interventions with each participant serving as their own control in estimating treatment effect [9, 10]. Participants were randomly allocated to complete either a spinal (SA) or general (GA) anaesthesia scenario in a SA-GA/GA-SA design (Fig. 2) [11]. There was no washout period between scenarios.

The study simulation took place in a dedicated operating room for suspected or confirmed COVID-19 patients at the Mackay Base Hospital. To maintain realism, the operating

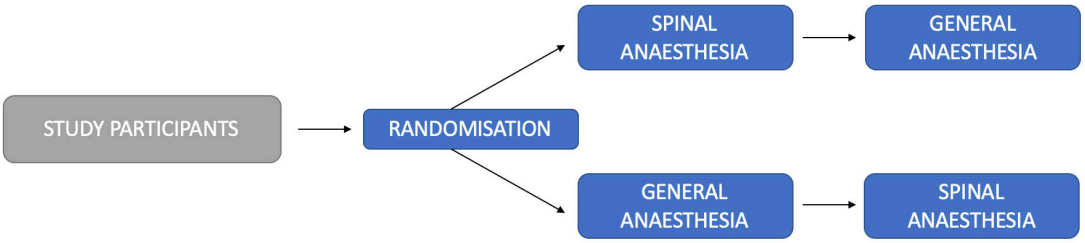

Fig. 2. Crossover Design [1].

room was prepared as it would be expected in an actual case. Participants and actors had access to flowcharts, equipment and medications used at our institution for management of suspected and confirmed COVID-19 patients. When possible, we reutilised personal protective equipment and medication ampoules to avoid excessive waste without changing the scenario dynamic. The flowchart used was based on recommendations on the perioperative management of suspected or confirmed cases of COVID-19 [12]. Participants were instructed to perform the scenario as they would in an actual case thus minimum prompting was provided by the actors during the simulation. Only people trained for the scenarios would be involved in the study.

The primary outcome of the study was the difference in time required to perform either general or spinal anaesthesia measured in minutes in the simulation environment. This time was measured once the patient entered the operating room until the completion of the anaesthesia. Other outcomes measured were the time to prepare the operating room for each technique (decision-making process); the total simulation time (the decision-to-incision time) and the level of stress of the participants.

The study participants offered informed consent for a comparison of two anaesthetic techniques in simulation environment for suspected or confirmed COVID-19 patients requiring an emergency caesarean delivery. They received no further instructions about the prior to the scenario and they were not informed that they were being timed to avoid bias. Timekeeping was performed by an investigator who was not participating in the simulation. The principal investigator was blinded for the time measurements.

In our institution, the parturient with suspected or confirmed COVID-19 remains in a dedicated labour ward suite which is distant from the operating room complex. Five minutes is required to transfer the patient to the operating room complex as measured in a simulation time prior to the study. This time was included in the study in order to maintain the most realistic simulation for our environment. This means that once patients were called to the operating rooms in the simulation, they would take 5 minutes to arrive in both SA or GA scenario. As per our institutional protocol for COVID-19 patients, operating room staff should be dressed in personal protective equipment prior to calling for the patient for the procedure. The PPE for both scenarios used was the same as per institution protocols. PPE used: Gown or apron/P2/N95/protective eyewear/Sterile gloves if required/Non-sterile gloves/Theatre cap/Shoe covers consisted in wearing a gown, a N-95 mask, glasses, hat and gloves. Due to difficulties surrounding staff availability to simulate all of the roles which would be required in an actual COVID-19 case, we were forced to limit the number of people involved in the simulation. For both scenarios there was an actor playing the parturient requiring caesarean delivery, an obstetric specialist, one nurse who prepared the operating room for the caesarean delivery and the anaesthetic team which comprised of the participant (a specialist anaesthetist), a junior anaesthetic trainee and a dedicated assistant to the anaesthetist (anaesthetic technician).

2.1 Simulation parts

For both the spinal and general anaesthesia simulations the scenario was divided to three distinct components. Part one comprised the anaesthetic trainee's "phone call", part two followed just after part 1 and it was the time required to prepare the operating room as per institutional guidelines and to wear PPE. Part three was the time when the patient arrived in the operating room and the participants performed either general or spinal anaesthesia as required by the scenario (primary outcome). Because the time to prepare the operating room for spinal anaesthesia or general anaesthesia may be different, we also analysed Part 1 and Part 2 separately as a secondary outcome. Further details surrounding the conduct of each phase of the scenario, including the instructions provided to participants are detailed in supplementary material.

Simulation of the spinal anesthesia scenario: The participant was told by the anaesthetic trainee during the phone call that the patient refused general anaesthesia for the procedure. For the technical aspects, participants were required to perform the procedure on a spinal injection simulator (Lifeform® Spinal Injection Simulator/NASCO, Fort Atkinson, WI, USA) once the parturient was deemed to be in an adequate position. In addition to personal protective equipment, standard aseptic precautions as governed by the Australian and New Zealand College of Anaesthetists (ANZCA) statement were followed [5]. Drug selection and dosages were at the discretion of the participant. The simulator has eas-

ily palpable lumbar spinous processes and spinal insertion was prompted to have occurred on the first attempt once the spinal needle was at an appropriate depth if no CSF was obtained. From previous research, we accepted 3, 4, 5 and 6 minutes as appropriate time to achieve T10, T8, T6 and T4 blockade levels respectively after completing the injection of local anaesthetic in the simulator [13, 14]. The level of the block was checked by the anaesthetic trainee as instructed by the participant. The scenario was concluded once surgical preparation was complete and the block was at an adequate height (T4) to facilitate safe delivery and the instruction had been given for the obstetric team to start the surgery.

Simulation of the general anaesthesia scenario: The participant was told by the anaesthetic trainee during the phone call that the patient refused spinal anaesthesia. For the procedure, as per institution protocols, the participants were required to use a plastic C-Arm drape over a frame to protect other staff from viral exposure during the induction and intubation period. A flowchart was available which contained a systematic approach to minimize aerosol generation. The induction of anaesthesia was simulated through an anaesthesia machine (GE Datex-Ohmeda) with live gas analyzers. Drug selection and airway equipment was at the participants discretion. For the purpose of the study, the scenario concluded once the muscle relaxant was injected to the intravenous line. The obstetric team was instructed to ask the participant if they were able to commence sterilization of the surgical field with chlorhexidine prior to the induction of anaesthesia. If the participant agreed to this request, then one minute was added following the injection of the muscle relaxant to allow for its action and the intubation process. If this request was refused, then four minutes were added following the injection of the muscle relaxant to allow for both the intubation process and for surgical field sterilization to take place by the obstetric team.

Following the completion of each scenario, the participants were asked to grade the stress associated with the conduct of general and spinal anaesthesia. This was completed on a standard 10-point scale with zero representing no stress at all and ten the most stress possible. In addition, we collected the participants age, gender and their anaesthesia experience measured in years since commencing a standardized anaesthetic training program. The time to complete each of the parts of the scenarios were measured in minutes.

2.2 Statistical analysis

Data was stored in a Microsoft Excel spreadsheet and analysed in SPSS for Windows Version 26 (IBM Corporation, Armonk, NY, USA). A post hoc power analysis was conducted using GPower to estimate required sample size. Based on our study means and standard deviations, with power (1-β) set at 0.80 and α = 0.05 a sample size of N = 8 was determined to adequately power the study. A post-hoc analysis was done Categorical data is presented as number (percent) while continuous data is presented as either median (range) or mean (standard deviation) as appropriate. Differences in means are represented as the difference with the associated 95th percent confidence interval. To allow for the crossover nature of this study, we used an independent samples *t*-test of the intra-individual differences of groups to examine for evidence of a carry-over effect between the first and second study periods and the scenario effect related to either spinal or general anaesthesia. Two tailed two sample *t*-tests were used to determine statistical significance with a threshold of $p < 0.05$ required to reject the null hypothesis of no difference between the two groups.

3. Results

Between the 3rd and the 16th June 2020, all specialist anaesthetists of the institution working there at the period (9 participants) accepted to participate in the study. There were no exclusions. There were 8 males and 1 female. The mean age of participants was 46 (range = 39–62) years, with a mean anaesthetic experience of 17 (6–31) years. Five anaesthetists (55.6%) were allocated to the group which underwent the spinal anaesthesia scenario first (SA-GA) while 4 anaesthetists (44.4%) underwent the general anaesthesia scenario first (GA–SA).

Overall and irrespective of group allocation the mean time to complete the spinal anaesthesia scenario was 27.4 (standard deviation = 7.8) minutes, while for the general anaesthesia scenario was 24.0 (7.2) minutes. There was no difference between these times (mean difference (GA–SA scenario) = –3.5 minutes, 95th percent confidence interval –9.7–2.8 minutes, p = 0.24). Breaking the scenarios down into three phases, there was no difference in time to completion at any point between the GA and SA scenarios, see Table 1.

When the data was analysed by group allocation, there was no evidence of a carryover effect for the two scenarios based on the group allocation (p = 0.69). There was no difference found between the time to complete the scenario based on group allocation (mean difference (GA–SA scenario) = –6.6 (–20.1–6.9) minutes, p = 0.29). On reviewing the three phases of the scenarios, no differences were found between the two groups at any point, see Table 2.

The mean reported stress level on the 10-point scale was 5.1 (1.9) for the spinal anaesthesia scenario and 4.8 (2.7) in the general anaesthesia scenario. There was no significant difference between stress levels for the two scenarios (p = 0.44). When the stress for each scenario was compared by group allocation, there was no evidence of a carryover effect (p = 0.73) and no difference was found between the two scenarios (mean difference (GA–SA scenario) = –0.8 (–2.7–1.2), p = 0.40).

4. Discussion

We have shown that the time taken to perform either spinal or general anaesthesia are not significantly different in a simulation scenario where patients with confirmed COVID-19 disease requires emergency category-1 caesarean delivery. There were no differences in the decision-making

Table 1. Demographics and scenario results.

Age (years)	46 (39–62)			
Sex (male)	8 (88.9)			
Anaesthetic experience (years)	17 (6–31)			
	GA scenario	SA scenario	Difference	*p*-value
Overall time (minutes)	24.0 (7.2)	27.4 (7.8)	−3.5 (−9.7–2.8)	0.24
- Part One	1.1 (0.4)	1.2 (0.3)	−0.1 (−0.4–0.3)	0.75
- Part Two	14.0 (3.2)	16.1 (5.7)	−2.2 (−5.5–1.1)	0.17
- Part Three	8.9 (4.3)	10.1 (3.0)	−1.2 (−5.3–2.8)	0.50
Stress level (10-point scale)	4.8 (2.7)	5.1 (1.9)	0.3 (−1.3–0.6)	0.44

Age and experience data expressed as mean (range) while time and stress data expressed as mean (standard deviation).

Differences expressed as mean (95th percent confidence interval).

time, the total time and both scenarios were associated with similar levels of stress for the participants.

Due to its favourable complication profile when compared to general anaesthesia, spinal anaesthesia has become the preferred technique for safe conduct of caesarean deliveries in most settings [15]. Anaesthetists, for this reason, are becoming less experienced in performing general anaesthesia for caesarean deliveries and approach to this technique with some trepidation. However, the conduct of emergency CAT-1 CD is many times advocated under general anaesthesia since this technique provides predictable onset time and it has been associated with more rapid decision to incision times across multiple studies [2, 16, 17].

In one study, the median time difference found was 7 minutes in operating room-to-incision intervals from general anaesthesia (6 min) to spinal anaesthesia (13 min) and in another, the decision-to-delivery interval was nearly 8 minutes faster for general anaesthesia (25 vs. 33 min) [16, 17]. Despite the advantage of speed, general anaesthesia was associated with an increased risk for Apgar scores of <7 at 5 minutes post-delivery, neonatal respiratory depression and admission to a neonatal intensive care unit. These differences have been shown to persist after adjustment for possible confounding factors meaning that short-term respiratory morbidity may be an effect of general anaesthesia [17]. Maternal complications such as venous thromboembolism, surgical site infection, anaesthesia related complications and severe anaesthesia related complications were also associated with general anaesthesia in situation where this technique could have been potentially avoidable [18].

In Australasia, the Royal Australasian College of Obstetricians and Gynaecologists (RANZCOG) has moved away from the association of rigid times with the decision to delivery interval [19]. Emergency or RANZCOG Category 1 caesarean delivery was previously associated with a decision to delivery interval of less than 30 minutes. The conduct of anaesthesia only occupies a small percentage of this process, yet the use of general anaesthesia leads to inferior maternal and neonatal outcomes. Systematic reviews have also shown there is minimal evidence to suggest that neonatal morbidity increases once the decision to delivery interval increases beyond 30 minutes [20–23]. Importantly, prospective investigations in this area would be challenging to conduct meaning that these recommendations are based on retrospective data. Although the use of spinal anaesthesia for emergency caesarean deliveries offers some attractive benefits, it is important for a practitioner to balance these outcomes with their ability to perform the procedure under the stress of possible foetal compromise.

The use of 'rapid sequence' spinal anaesthesia whereby standard techniques are modified to facilitate prompt onset of surgical blockade could facilitate reductions in the time required to prepare and perform spinal anaesthesia and allow surgery to commence expeditiously [24]. One of the core tenants of this technique is allowing surgery to commence once the sensory block has reached T10 and is ascending. In our study most of the participants waited until the block was at the T4 level despite several participants expressing a desire to use the technique. These findings reinforce the need for appropriate training in situations where the decision-making process is critical and appropriate technical skills are crucial to provide good outcomes.

Our study infers that SA may be a more suitable technique for patients with suspected or confirmed COVID-19 even when time factor is critical. This technique appears to be safe to perform for this population as shown in a few published reports [25, 26]. In the largest, spinal anaesthesia was able to be performed in 14/17 parturients with confirmed COVID-19 disease. Apart from the authors recommending regional anaesthesia as the technique of choice for this population, the remaining parturients had general anaesthesia due to foetal distress. Unfortunately, this series did not report the decision to delivery interval to allow any inference on the speed with which spinal or general anaesthesia was performed.

General anaesthesia and tracheal intubation where aerosolization of infectious particles can occur is an inherently perilous situation for the healthcare workers involved. These risks can be mitigated through the use of personal protective equipment and aerosol or intubation boxes. In simulation studies the use of aerosol boxes has led to breaches

Table 2. Analysis of data by crossover groups.

	GA–SA group	SA–GA group	Difference	*p*-value
Number (percent)	4 (44.4)	5 (55.6)		
GA scenario (minutes)	26.0 (11.1)	22.3 (2.2)	3.6 (–8.2–15.4)	0.49
- Part One	1.2 (0.5)	1.0 (0.3)	0.2 (–0.4–0.9)	0.42
- Part Two	15.4 (4.2)	12.8 (1.7)	2.6 (–2.2–7.5)	0.24
- Part Three	9.3 (6.9)	8.5 (1.2)	3.5 (–10.0–11.6)	0.83
SA scenario (minutes)	27.9 (12.4)	27.0 (2.3)	0.9 (–18.6–20.3)	0.90
- Part One	1.0 (0.2)	1.3 (0.4)	–0.3 (–0.8–0.1)	0.13
- Part Two	17.1 (8.6)	15.4 (2.6)	1.7 (–7.8–11.2)	0.68
- Part Three	9.8 (3.8)	10.4 (2.5)	–0.5 (–5.5–4.5)	0.81
Total time	55.9 (20.0)	49.4 (3.1)	4.5 (–26.9–35.9)	0.69
Carryover effect				
- Overall				0.69
- Part One				0.81
- Part Two				0.53
- Part Three				0.95
1st scenario to 2nd scenario				
- Overall	–1.9 (–0.5–1.0)	4.7 (0.7–0.9)	–6.6 (–20.1–6.9)	0.29
- Part One	0.3 (–0.4–0.9)	0.3 (–0.2–0.8)	0.0 (–0.7–0.6)	0.88
- Part Two	–1.7 (–12.2–8.9)	2.6 (0.3–4.8)	–4.2 (–11.4–3.0)	0.21
- Part Three	–0.5 (–12.4–11.3)	1.8 (–2.6–6.2)	–2.3 (–11.2–6.5)	0.55
Stress				
Carryover effect				0.73
1st scenario to 2nd scenario	–0.8 (–3.5–2.0)	0.0 (–0.9–0.9)	–0.8 (–2.7–1.2)	0.40

Time and stress data expressed as mean (standard deviation).

Differences expressed as mean (95th percent confidence interval).

in personal protective equipment and significant increases in the time to secure the airway by experienced specialists [4]. Others have reported that up to 10% of those involved with airway management of COVID-19 positive patients are diagnosed with the condition themselves or required self-isolation in the seven days following the intubation [27]. Although it is difficult to attribute a true causal relationship as many of these encounters occurred in settings where widespread community spread existed, it is possible that transmission of the virus could occur to workers in this setting. The Australian and New Zealand College of Anaesthetists does not consider spinal anaesthesia by itself to be an aerosol generating procedure, however in the case of spinal anaesthesia, the backup should the technique fail is general anaesthesia meaning the same personal protective equipment as is used to perform general anaesthesia is required when spinal anaesthesia is performed.

There are some limitations in our study. Simulation research may have restricted external validity due to the number of biases inherent to these types of studies. The PPE used in other anaesthetic departments may be completely different from the equipment used in Australia and the differences in time we found may not be realistic. The findings of our study depend on the protocols used in COVID-19 patients. If protocols for PPE differ in other institutions which would make time for induction of general anaesthesia shorter, the results may not be applicable. Moreover, we only studied 9 staff specialists that have diverse experience in obstetric anaesthesia in a single centre. This further reduces considerably the generalizability of our findings and caution should be used prior to recommending a change of practice based on this study. Another concern is that the induction of anaesthesia and the performance of spinal anaesthesia were meant to be easy in the scenarios. However, in a real emergency situation, patients can be more challenging to perform anaesthesia and this should also be taken in consideration when choosing the most appropriate technique. Additionally, creating a stressful environment for an emergency category-1 CD in a patient with COVID-19 was very difficult and therefore, the findings may not translate to a real situation. Supporting this problem, we couldn't find a difference in the stress levels amongst participants for both our scenarios. We also didn't include a washout period due to the difficulties to study the same staff specialist in different days. Finally, although the difference of three minutes between both techniques did not reach statistical significance in our study, this time may be clinically important in situations where prolonged foetal distress is considered.

On the other hand, this study reinforces the recent recommendations to consider spinal anaesthesia as one option for emergency category-1 caesarean deliveries due to foetal distress in any situation. Our study showed, however, that proper training is required to avoid harm to the baby and the parturient. Although we only studied only 9 specialist anaes-

thetists, this study was powered for the primary outcome and these participants are representative of the standard of practice in a larger cohort of specialist anaesthetists in Australia and in many other countries. In particular, their response to the onerous process required to perform GA in suspected or confirmed COVID-19 patients, could be extrapolatable given the uniform clinical standard in our cohort.

5. Conclusions

Overall, the time to perform spinal anaesthesia was similar to general anaesthesia in a patient with COVID-19 disease requiring emergency caesarean delivery in a simulation environment. Our findings added to the recent recommendations to consider spinal anaesthesia for emergency category-1 caesarean deliveries due to foetal distress, it is our opinion that neuraxial anaesthesia when not contraindicated, should be considered the primary anaesthetic of choice for suspected or confirmed COVID-19 parturients requiring emergency caesarean deliveries. However, adequate training to perform this technique under these circumstances is required to avoid delays which may lead to possible maternal and foetal complications. Further studies may be required to evaluate time of induction of general anaesthesia based on changes in practice once medical practitioners become vaccinated and potentially immune to COVID-19.

Author contributions

MEK Principal investigator and first author. Contributions: Study design, data collection and manuscript writing. NJL contributions: Statistical data analysis and manuscript writing. CS contributions: Study design and manuscript writing. AP contributions: Study design, data collection and manuscript writing. AJ contributions: Study design, data collection and manuscript writing. DB contributions: Study design, data collection and manuscript writing.

Ethics approval and consent to participate

This study was prospectively approved by the Townsville Hospital and Health Service Human Research Ethics Committee (HREC/QTHS/63914) and was registered on the Australian and New Zealand Clinical Trials Registry (ANZCTR - ACTRN12620000579998). Informed written consent was obtained from the nine specialist anaesthetists who participated in the study. The trial was performed according to the Declaration of Helsinki. Our study complies with the Consolidated Standards of Reporting Trials (CONSORT) guidelines (CONSORT Checklist); a CONSORT flow chart is presented in Fig. 1.

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Conflict of interest

The authors declare no conflict of interest.

Appendix

Simulation Script

Part One—Phone call

For the General Anaesthesia scenario, the specialist anaesthetist received a phone call from an anaesthetic trainee about a parturient with persistent foetal bradycardia requiring emergency (RANZCOG Category 1) caesarean delivery. The woman was otherwise healthy apart from recently returning a positive swab for SARS-CoV2 (COVID-19). The trainee would inform the participant the patient had mild respiratory symptoms, no fever and was not requiring oxygen therapy. Her blood investigations were all normal. The woman had informed the obstetric staff that she was refusing consent for spinal anaesthesia. The anaesthetic trainee would inform the participant that they had activated the COVID-19 theatre team and would meet them in the dedicated OT for a "huddle" to prepare. For the spinal anaesthesia scenario, the only difference was that the patient would refuse general anaesthesia. The end of Part One was once this phone call concluded.

Part Two—Operating Room Preparation and PPE

For both scenarios, participants were able to use institutional COVID-19 specific flowcharts for airway management and caesarean delivery, standard equipment, and medications needed for both general and spinal anaesthesia. The decision to make use of these resources' flowchart and drug selection and airway management tools was at the discretion of the participant. The conclusion of this phases of the simulation occurred once the participant called for the parturient from the labour ward. As per institution protocol, COVID-19 patients can only be called when all staff were adequately dressed in personal protective equipment. As transport of the patient to the operating room would take at least five minutes, five minutes was added to the participants cumulative time from this moment.

PPE: For both scenarios - Gown or apron/P2/N95/protective eyewear/Sterile gloves if required/Non-sterile gloves/Theatre cap/Shoe covers

Part Three—Performance of Spinal or General Anaesthesia

Once the parturient was in the operating room, standard monitoring was applied to the actor and intravenous fluids attached. The obstetric specialist would mention the foetal bradycardia was persistent and that there was still a requirement for the emergency caesarean delivery. Additional details surrounding airway management and the performance of spinal anaesthesia are detailed in the methods section.

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