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REVIEW ARTICLE

Perimortem caesarean deliveries

A.J. Eldridge, R. Ford

Anaesthetic Department, Queen Alexandra Hospital, Portsmouth, Hampshire, UK

ABSTRACT

Although cardiac arrest in pregnancy is rare, it is important that all individuals involved in the acute care of pregnant women are suitably trained, because the outcome for both mother and fetus can be affected by the management of the arrest. Perimortem caesarean delivery was first described in 715 BC. Initially the procedure was performed principally for religious or political reasons. Although the potential for fetal survival was proposed, it was rarely successful, probably because the delivery was delayed until maternal death was established. However, in recent decades, case reports have suggested improved maternal as well as fetal survival if perimortem caesarean section was performed rapidly once maternal arrest has occurred. While evidence for this is largely based on case reports, the physiological advantages including removing inferior caval obstruction, and hence improving venous return to the heart, reducing oxygen requirement and improving chest compliance appear compelling. Factors that reduce errors and minimise the delay in performance of caesarean delivery are discussed, in particular the importance of training, organizational factors within a hospital and the use of prompts during an arrest. While evidence is limited, it is probable that both maternal and fetal survival are improved with early delivery by perimortem caesarean delivery. More importantly, no evidence was found from case report reviews that either maternal or fetal survival was worsened. Perimortem caesarean delivery therefore remains a key consideration in the management of maternal arrest from the mid second trimester.

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Introduction

Between 2009 and 2012 there was a welcome reduction in the number of maternal deaths in the UK.¹ However, despite the effort that is put into early detection and intervention in critically-ill women,^{2,3} cardiac arrests still occur. In the event of an arrest, management of that arrest can still alter outcome. Perimortem caesarean delivery (PMCD) is recognised as one of the key interventions that influences survival of both mother and baby. Despite this, between 2006 and 2008, approximately one third of pregnant mothers who died in the UK after 24 weeks gestation remained undelivered at the time of death.²

History

Postmortem caesarean delivery has been described for thousands of years. Cultural references to postmortem caesarean delivery can be found in English, Egyptian, Greek, Roman, Native American and Scandinavian texts.⁴ While many reports have been mythical, clear legal reference to the procedure is described in 715 BC

when the Numa Pompilius in the Lex Regis de Inferno Mortis declared that with maternal death, the fetus should be “ab matris césar” (cut from the mother), and hence one of the possible origins of the term “caesarean section”. Since then, some interpretations of religious texts have required postmortem caesarean delivery to be performed. For instance, in 1280, the Church Councils of Cologne enacted a law requiring the fetus not to be buried before baptism. Although controversial, similar concepts have been proposed in the Jewish, Islamic and Hindu faiths.^{5,6}

In 1305, a postmortem caesarean delivery was performed by Bernard of Gordon, in Montpellier and is said to be the first carried out with the specific intention of fetal rescue. Similar operations followed. However, as these procedures were usually not undertaken until maternal death was established, fetal rescue was rarely successful. In 1837, a report delivered in Paris found only seven fetal survivors from a total of 49 postmortem caesarean deliveries. A similar report 11 years later from Kurhessen, Germany, found no fetal survivors in 107 postmortem caesarean deliveries and in 1864, a report presented at the Berlin Obstetrical Society found only three infant survivors in 147 procedures.⁴ This led many to question the value of postmortem caesarean delivery.⁷

Despite much pessimism, there continued to be intermittent reports of good fetal outcome through the

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Correspondence to: Dr James Eldridge, Anaesthetic Department, Queen Alexandra Hospital, Portsmouth, Hants PO6 3LY, UK.

E-mail address: james.eldridge@porthosp.nhs.uk

nineteenth and early twentieth centuries. In 1982 two key reports were published that associated PMCD with the unexpected survival not only of the fetus but also the mother. Firstly, Marx reported five women who suffered cardiac arrest associated with bupivacaine toxicity.⁸ Of the three women who were delivered expeditiously, all survived without major consequences, but both women whose delivery was delayed suffered irreversible brain damage. Marx hypothesised that the return of spontaneous circulation (ROSC) was related to the relief of aortocaval occlusion and recommended early delivery in the event of maternal cardiopulmonary arrest. Within a few months, DePace described a similar event. A woman in late pregnancy arrested during a bronchoscopy associated with major haemoptysis.⁹ After 20 minutes of unsuccessful maternal resuscitation, PMCD was performed in an attempt to rescue the fetus. Not only did the fetus survive, but as soon as the fetus was delivered, maternal circulation was re-established and both survived without sequelae.

Although not reported at the time, two years later, Dr Vern Katz, an American Obstetrician, was also involved with a maternal cardiac arrest. After 22 minutes of cardiopulmonary resuscitation (CPR), a PMCD was performed. The fetus survived, and although the mother did not, Katz noted that CPR produced a palpable pulse only after the uterus was emptied.⁴ Katz went on to review all case reports of PMCD between 1879 and 1986.¹⁰ He found a rate of fetal rescue much higher than previously suspected, with 188 infant survivors from a total of 269 reports of PMCD, although he acknowledged that under-reporting of non-survivors was highly likely. He was also struck by a promising association between fetal delivery and maternal ROSC and speculated on potential advantages to the mother of PMCD.

The combination of possible benefit to both fetus and mother lead Katz to recommend PMCD in the event of maternal arrest.¹⁰ Although research into maternal arrest was and remains limited, with evidence largely derived from non-pregnant women, case reviews, physiological principles and expert opinion, both the American Heart Association (AHA)¹¹ and the European Resuscitation Council (ERC)¹² endorsed his concept of early PMCD.

Incidence

Robust data on how often cardiac arrests occur in pregnancy are difficult to obtain. Arrests are often under-reported and estimates vary markedly. In the Netherlands a series of case reports between 1998 and 2011 suggested the incidence was approximately 1 in 55000.¹³ The most widely quoted UK estimate is 1:30000 maternities. This figure has been referenced to several Confidential Enquiry Reports from 1976–78¹⁴ to 2000–02,¹⁵

and is compatible with the 2014 interim results of the UK Obstetric Surveillance System (UKOSS) report which suggested the incidence of maternal arrest in the UK to be approximately 1:35000 pregnancies.¹⁶ However, as the overall UK antepartum mortality rate in 2000–02 was 1:26000¹⁵ and as the survival following arrests is probably greater than 50%,¹⁷ these estimates may be questioned. In the USA, data from the National Inpatient Sample between 1998 and 2011, indicated that cardiac arrests complicate 1:12000 hospitalisations for delivery.¹⁸ Regardless, although rare, it is likely that a cardiac arrest in a pregnant woman will be seen every few years in all large maternity units.

Theoretical rationale for perimortem caesarean delivery

Although pregnant women are generally young and fit, the fetoplacental unit causes physiological changes that may challenge the mother, particularly if critically unwell. Oxygen consumption is increased by 20%, functional residual capacity is reduced and pulmonary shunt increased,¹⁹ all accelerating the development of hypoxia and acidosis. Chest compliance is reduced, while intra-abdominal pressure increases, causing an increased risk of regurgitation. However, in the event of a cardiac arrest, probably of greatest significance, is the occlusion of the inferior vena cava (IVC) by the gravid uterus when the mother is supine.

Supine aortocaval occlusion is common in the second half of pregnancy and becomes more severe as the fetus grows. Most women avoid the supine position in late pregnancy although only about 10% of women become overtly hypotensive. Rarely, the supine position by itself may be implicated in causing cardiac arrest, particularly when combined with neuraxial anaesthesia.^{20,21} Radiographic evidence from the early 1960s and more recent magnetic resonance imaging (MRI) evidence, suggest that supine women in the third trimester commonly have complete occlusion of the lower end of the IVC.^{22,23} Given that approximately two-thirds of venous return to the heart is from the IVC,²⁴ it is perhaps surprising that so few suffer hypotensive symptoms. The lack of hypotension is presumably because there is sufficient collateral circulation. At its upper end, the intrahepatic IVC can be imaged and its diameter used as a surrogate marker of left atrial filling from the IVC. A study of the diameter of the intrahepatic IVC in late pregnancy found that the supine position reduces the intrahepatic venous diameter, so in most individuals the collateral circulation is not sufficient to return IVC flow to normal.²⁵ Quantitative cardiovascular magnetic resonance also demonstrates that right ventricular stroke volume and cardiac output are significantly decreased in the supine position in late pregnancy when compared with left lateral position, whereas the reverse is found in

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