

# A Tale of Moths and Mothers – Is Vaginal Birth an Evolutionary Advantage or an Outmoded Natural Function?

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## Abstract

Since the mid-20th century, the efficiency and utility of Caesarean section (CS) in England and Wales has evolved immensely. While there is clearly a case for performing major abdominal surgery in extenuating circumstances, there is also the suggestion that ease of access may be leading towards over-use and, as a consequence, negative gain. The decision to perform a CS is based on obstetric clinical judgment and, while all practitioners share a genuine concern for childbearing women, a polemic has emerged. This involves some obstetricians and midwives wishing to curb Caesarean births, while others attempt to normalise them to the point of promoting 'natural, woman-centred caesarean sections'. This article offers an additional dimension to the Caesarean debate, adopting a slightly controversial evolutionary perspective. The paper begins with a brief overview of the history of CS and then ponders possible long-term implications from an evolutionary perspective, re-visiting the challenging obstetric hypothesis that increasing CS rates, if taken to the extreme, could potentially strengthen the future human gene pool. It then ponders whether this could equally weaken it and argues for more medical and midwifery support to be channelled into promoting the benefits of normal birth to the public.

## Keywords

History, obstetrics, Caesarean section rates, human reproductive evolution

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In the 20th century, assisted by a vast array of rapid parallel developments in science, medicine, surgery, neonatology, pharmacology and biotechnology, and further supported since 1948 by a system of free maternity services, rates of Caesarean section (CS) in England and Wales have escalated. As late as 1957, the percentage of CSs for all births was as low as 2.4%.<sup>1</sup> By 1970, the national average rate was estimated to be 4.9% and by 1980 9%, while by 1998 it had risen to 18.2% in England.<sup>2</sup> In 2011, the CS rate had reached a national average of around 25%, varying significantly between NHS hospitals and between elective and emergency settings.<sup>3</sup>

In a consumer-oriented, litigious society, where CS has become the norm for around one in four birthing women, a polemic has emerged among the midwifery and medical professions, with protagonists debating the desirability of normal birth versus the normalisation of Caesarean birth – both groups claiming to provide what informed women want.<sup>4</sup> While there is clearly a case for performing major abdominal surgery in extenuating circumstances, it is also possible that it may now have reached or passed its optimal rate of efficiency, so that the effects of a more extensive use of CS on women and on society will become less significantly advantageous.<sup>5</sup> This article briefly explores the history of CS from around 1500 until the present time, then turns to examine the procedure from an evolutionary perspective, considering some of the possible long-term implications of the increased use of CS. Finally, whereas it has been suggested

that increasing the CS rate could potentially strengthen the human gene pool,<sup>6</sup> this article ponders the alternative possibility that it could serve to weaken it or lead to an evolutionary 'dead end'.

## Brief History of the Caesarean Section Early Attempts

In Greek medicine, obstructed labour was not clearly identified or articulated as a concept, and delay in labour and death of the foetus *in utero* was often simply attributed to its being a 'weak and sickly' infant unable to force its own way out into the world.<sup>7</sup> Before the relatively recent success of CS on a live woman, it was rarely carried out for foetal reasons, a possible exception being to deliver a future heir or nobleman from its dying mother. Some of the first operations were performed *in extremis*, when all else had failed and there was nothing to lose, as the mother was almost certainly by then consigned to an untimely death. On rare occasions, a post-mortem Caesarean operation was reported to have retrieved an offspring from its dying or recently deceased mother. While a faint hope of saving the child might justify the operation, it was also seen to provide a brief opportunity for emergency baptism before the infant died, and allowed mother and infant to be physically separated before their burial.

During the early modern period in England and Wales, before forceps were in common use, internal podalic version was used to attempt to remove the foetus, legs first, from the uterus. This often proved difficult,

**Figure 1: Illustration from Charles Estienne's Book *De Dissectione Partium Corporis Humani Libri Tres* (Paris, Colines, 1545)**



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although the 17th-century man-midwife Percival Willughby claimed some success with this procedure.<sup>8</sup> In cases where the foetus could not be easily accessed and manipulated into a suitable position for a cephalic or breech delivery, the only remaining option offering a glimmer of hope for the life of the mother was to remove the foetus piecemeal.

Up until 1735, there were very limited ways of dealing with protracted labour. By the mid-18th century, the more widespread use of the midwifery forceps, lever and vectis offered some hope of delivering an intact live baby, although this was sometimes hampered by pelvic contraction or distortion, which could limit access to the foetus.<sup>8,9</sup> Apart from the risky Caesarean operation, embryotomy (embryulcia was another term used) was the only other option. Such operations required great manual dexterity and stamina on the part of both mother and operator, as the procedure was long, arduous and gory. It basically involved removing the dead foetus piecemeal *per vaginam*, using hooks (the 'crochet') and other destructive instruments. Sometimes, craniotomy, decapitation, evisceration or cleidotomy was performed to reduce the bulk of the foetus, further increasing the risks of haemorrhage, trauma, puerperal fever and maternal death.

Less popular experimental methods were also tried in England during the 18th century, including induction of labour, which was sometimes difficult to initiate; also, inaccurate assessment of gestational age could lead to surgeons being accused of terminating the life of the infant. Symphysiotomy, introduced from France around 1778, was also experimented with, but was considered barbaric by some and of limited utility.<sup>10</sup>

### Pioneering of the Operation (1500–1700)

Knowledge of human anatomy was assisted by the removal of bans on human dissection in a number of universities in Europe during the 14th to 16th centuries. Advances in techniques of human dissection are commonly attributed to Andreas Vesalius (whose illustration of female pelvic anatomy is detailed) and the advent of the printing press in the 15th century. This enabled anatomical sketches to be produced and disseminated to medical students on an international scale. The quality and detail of these was variable. *Figure 1*, by Charles Estienne, was relatively crude, although such material was also of interest to the public. By the 18th century, anatomical diagrams of female reproductive organs, pregnancy and birth had improved greatly, assisted by widespread illicit human dissections, further developments in printing, and the commissioning of accomplished artists to do drawings based on direct observations of human dissections.

Much has been written about the Caesarean operation, which was pioneered in Europe, particularly in France, where dismembering the foetus appeared to be more abhorrent than risking the mother's life during such an operation.<sup>9,11</sup> In 1581, the French physician François Rousset documented the possible advantages of the CS on live women, referring to several previously successful operations and proposing criteria for its use.<sup>12</sup> It was clearly more likely to be successful if performed before the mother became moribund, enabling her to withstand the tough operation. However, its success was quite limited, and many *accoucheurs* were reluctant to perform it without the support of colleagues and the clergy, for fear of being held responsible by the family for the death of the mother. Most of the early attempts at CS were carried out in France. In England, many men-midwives, while curious about it, were more reluctant to attempt the procedure given its limited success rate, and often preferred embryotomy as a possible means of saving the mother's life.<sup>11</sup> The merits or otherwise of the Caesarean operation were a topic of international debate among the *accoucheurs* or men-midwives of the period.

### Environmental Reasons for the Increase in Contracted Pelves and Obstructed Labour in Early Modern Britain

Long working hours in factories during the industrial revolution, poor diet, smog and lack of sunlight in cities, fashions of female clothing and the culture of spending long periods of time indoors have all been identified as contributing to high levels of rickets and osteomalacia in adult women, affecting their pelvic shape and capacity to give birth.<sup>11</sup> Osteomalacia, known formerly as *mollities ossium* (literally 'soft bones'), created similar pelvic deformities to rickets but sometimes allowed a degree of pelvic expansion to permit a vaginal birth.<sup>9,10,13,14</sup> Congenital malformations of the pelvis and spinal scoliosis also affected birthing capability and were more prevalent in the past, but, as many of these women died in childbirth, such congenital abnormalities appeared less frequently in future generations.<sup>9,15,16,17</sup>

## A Midwife's Perspective

When the English midwife Jane Sharp wrote *The Midwives Book* in 1671, almost all births took place at home with a midwife in attendance, medical men being relatively few in number. Hobby reports that, at this period, around '80–85 % of all babies survived at least for a few years post-delivery' and 'a woman's cumulative risk of dying in childbed, through her probable six or seven pregnancies, was less than 10 percent'.<sup>18</sup> Sharp discusses the removal of a dead child using a hook<sup>19</sup> and mentions the name of 'Francis Ruset'.<sup>20</sup> She also refers to other early Caesarean advocates, while expressing the personal opinion that the operation was untenable 'whilest the Mother is alive',<sup>21</sup> although, if the 'child was thought to be alive and the mother at the point of death', Sharp would endeavour to 'assist the child in breathing by keeping open the mother's mouth and privities [private parts], to aerate the fetus' until a post-mortem Caesarean operation could be performed.<sup>20</sup>

## Further Work (1700–1900)

Surgeons in France carried out more operations during the ensuing decades. Statistics provided by Jean Baudelocque of France to John Hull of England around 1799 present some interesting but sobering cases of successful and unsuccessful caesarean sections. In his *Observations on Mr Simmons's Detection ...*, John Hull recorded a total of 112 known cases since 1500, in which 43 mothers had died and 69 had survived. He also included Baudelocque's data of known cases in France since 1750, in which only 31 out of 73 women's lives had been preserved by the Caesarean operation.<sup>22</sup>

During the late 19th century, the operation was pioneered in Britain, particularly in Scotland<sup>23</sup> and North West England,<sup>24</sup> which happened to have the most cases of severe cephalopelvic disproportion, mainly attributed to rickets. The first successful operation in England was performed in 1793 by a Mr Barlow of Chorley, Lancashire, on a woman who had laboured for five days. By the 1880s, significant improvements in operative technique had been made: the uterus was sutured in layers, the abdomen was cleared of excess blood, aseptic technique had improved, and women were operated on slightly earlier when in better condition and less likely to suffer from infection.

## From Dangerous to Banal (1900–2012)

In the early 20th century, the problem of bony dystocia gradually began to decrease, whereas the CS rate continued to increase slowly but steadily.<sup>4</sup> In 1902, the Midwives Act aimed to ensure midwives were all registered and educated to a minimum standard upon qualification. Their role in working with women was seen as crucial, along with sanitary reforms, if significant improvements to the poor state of the health of the nation were to be achieved. Over the course of the 20th century, a number of medico-social and political changes took place, which facilitated open access to antenatal and intrapartum surveillance by midwives, general practitioners and obstetricians, increasing opportunities for more timely medical intervention. Subsequent health policies led to more centralised maternity services and promoted a dramatic decline in home births and an equally dramatic rise in hospital births, to the point when, in the Peel Report of 1970, hospital birth was recommended for all.<sup>25</sup> There were also improvements in birth mortality and morbidity rates, which were initially attributed to increased levels of medical intervention, but subsequently also more widely to improvements in the general health of women and in the environment.<sup>26</sup> Clinical

developments in anaesthesia and pharmacology (chiefly antibiotics and oxytocics, but also the contraceptive pill in 1960) and the use of blood transfusions and radiography all contributed to the rise in CS rates. Medical litigation led to defensive obstetrics, and the use of more birth technology increased foetal surveillance and promoted foetal medicine. Parallel developments in the fields of paediatrics and neonatology facilitated life support for increasingly pre-term infants and new reproductive technology contributed to higher rates of multiple pregnancy.<sup>4,27</sup> While birth was revolutionised in the West, the original indication for the Caesarean operation, bony dystocia, faded somewhat into the background.

## The Female Pelvis and the Process of Evolution

The concept of adaptation is fundamental to evolutionary theory. An adaptation is a change or modification that enables an organism to survive in order to reproduce and transmit its genes within a given environment.

## Adaptation

The fortunes of the peppered moth *Biston betularia* provide a classic example of a relatively rapid biological adaptation. The predominant phenotype of populations of the moth inhabiting unpolluted environments is predominantly light with some dark specks. However, it was observed that, in heavily polluted industrial areas, where the bark of trees was darkened by soot and grime, the predominant phenotype had become much darker. This can be explained by the existence of strong selection pressure, in such an environment, against the lighter phenotype, which was highly visible against the darkened tree bark, leading to selective predation by birds.<sup>28</sup> Once pollution levels decreased, the lighter phenotype re-established itself, as now the darker moths were more visible against the lighter bark.

Another example of a type of genetic mutation which became established through conferring selective advantage in a particular environment, this time in human populations, is the haemoglobin abnormality that gives rise to sickle cell disease. Although the homozygous form of this condition is deleterious, the heterozygous form confers considerable protection against malaria, leading to the selective transmission of the gene among populations in affected areas. A similar instance of advantageous micro-evolution was the acquisition, via the spread of a genetic mutation, of lactose tolerance in early pastoral communities.

There are instances where the effects of deleterious genes in human populations are commonly ameliorated via medical technologies; here, selection pressures against individuals affected by a genetic condition are considerably reduced, leading to possible increases in the frequency of the deleterious mutation within these populations. Isoimmunisation, the risk of which is reduced via anti-D injections, provides one example. Similarly, certain congenital defects are becoming rarer, although they have not been eradicated from the gene pool; prenatal diagnosis provides women with the option to abort an affected pregnancy.

## Evolution of the Human Species

Four million years ago, the early hominids developed the ability to walk on their 'hind legs' (bipedalism), which appeared to give them a number of evolutionary advantages, giving rise to a variety of teleological explanations.<sup>29</sup> First, the shift to bipedal locomotion freed up their 'front feet' to be used as hands, which led to the use of tools

around 1.5 million years later. Second, the increase in height and field of vision was especially useful for hunter-gatherers when foraging and hunting and for avoiding predation. Third, the upright posture meant that less of the body surface was directly exposed to the sun's rays. The upright posture required additional muscularisation to maintain bowel and bladder continence, and naturally affected childbearing and birth, which in quadrupeds involved the foetus traversing a tubular-shaped birth canal. Foetuses of bipedal hominids were required to exit the womb through a deeper, curved tube necessitating the negotiation of three pelvic planes, which on the whole they successfully achieved. Around 500,000 years ago, encephalisation (skull and brain growth) took place, eventually giving rise to the modern hominidae.

Physical anthropologists have noted that early hominids were possibly more efficient at birthing because their offspring possessed proportionately smaller head to maternal pelvis ratios. However, Wittman and Wall contend that, while this gave distinct ecological and social advantages to humans over other species, in real terms the foetus became nearly twice as large in relation to maternal size when compared with other primates. They also note, however, that the relationship of cranial size to body size in the human neonate is proportionate to that of other primates.<sup>29</sup>

Thus, while there is less free space in the pelvis of modern woman at term, foetal head size generally remains compatible with maternal pelvic capacity and does not actually hamper long-term brain growth; this occurs rapidly with maternal nurturance, during a phase of 'secondary altriciality' in which the baby continues to mature after birth at an accelerated rate.<sup>29</sup>

## Individual Natural Design?

The various bones of the female pelvis exhibit a range of individual features, accounting for slight variations in individual overall pelvic form. This renders Caldwell and Moloy's attempts at pelvic classification in the 1930-40s problematic; their four main 'parent' pelvic types – gynaecoid, anthropoid, platypelloid and android – included a vast number of subclassifications.<sup>30,31,32</sup> These researchers found that the female pelvis tended to be wider than the male prototype, possibly influenced by hormonal activity in adolescence, providing advantages for women during childbirth; however, the 'male types' of pelvis could also be found in women and vice versa.

As Roy notes, dystocia appears to be unknown in wild animals. Interestingly, moderate symphysis pubis diastasis and pelvic joint separation is a normal feature of pregnancy and has recently become more widely recognised and noted in pregnant women. This allows for a small degree of pelvic expansion at the symphysis pubis and the sacroiliac joints during birth, the 'disadvantage' being that it sometimes leads to pelvic instability. Nonetheless, in normal cases, it slightly assists birth, especially when combined with moulding of the foetal skull.<sup>33</sup> In some small rodents this process has developed more fully; during pregnancy, the symphysis pubis softens to become a fibrous tissue, which stretches to permit the birth of relatively large offspring.<sup>34</sup>

The drivers of adaptations come in many guises and often involve certain compromises. Wiley considers sociopolitical forces to be equally powerful determinants of health and disease.<sup>35</sup> For example, changes to the social environment since the advent of the printing

press have created the need for increased levels of close work and reading, which appear to have increased levels of myopia. Myopia in hunter-gatherer populations is a significant disadvantage, as it can expose affected individuals to danger, but is not in more developed societies, where spectacles and laser treatment are available.

## The Caesarean Operation – An Evolutionary Advantage?

CS has become an increasingly common intervention in the developed world. In 1998, a professor of obstetrics, Philip Steer, in an article that discussed future birth trends and the impact of CS from an evolutionary perspective, put forward the rather contentious suggestion that CS should be seen as an advantageous form of adaptation. He wrote: *'Rather than indulging in reflex pleas to "return to the simplicity of nature" (which is often "red in tooth and claw"), we should be concentrating on making caesarean section even safer, researching ways to predict labours that will have an adverse outcome, and listening to what (properly informed) women want.'*<sup>6</sup>

Steer contends that whether or not the cost of CS is acceptable 'depends on the value assigned to maternal autonomy in relation to convenience, avoidance of pain and damage to pelvic structures and her desire to protect her baby'.<sup>6</sup> Here he appears to be reducing the issue to one of a supposedly rational consumer choice, disregarding the fact that such a choice may be available to relatively few women if payment was involved. And, as the urogynaecologist Ingrid Nygaard contends, most women do not require urogynaecological surgery after a vaginal birth, and Caesarean delivery is not completely preventive of pelvic floor damage, which leads her to conclude that *'advocating caesarean birth to decrease pelvic floor disorders is ill-advised'*.<sup>36</sup> Advocates of CS for breech birth have couched this in terms of protecting the baby, which it undoubtedly is now that junior obstetricians and midwives have less opportunity to develop their clinical skills of vaginal breech birth. The matter of cost plays an important part in determining our future reproductive capacity, and possibly requires more careful consideration by the professions, politicians and the public. In 2011, a CS cost £2,369, whereas a vaginal birth cost £1,665.<sup>3</sup>

Evolution is concerned with survival of the fittest, as expressed in the ability of an organism to reproduce and transmit its genes. The major question that presents itself is: why do humans currently require so much medical assistance with birth? What has happened to the notions of adaptation and survival of the fittest, as propounded by Darwin and others? In contrast to the common perception of *Homo sapiens* as sitting at the apex of the evolutionary process, Steer contends that *'it is better to see ourselves in transition from what we were to what we must become if we are not to follow many previous species to extinction'*.<sup>6</sup> Like all other species, we need the ability to adapt in order to avoid facing extinction. Steer maintains that CS, if seen as a type of evolutionary adaptation, should perhaps become the norm; originally a medical solution to dystocia, it could become so safe that *'for most women the unpredictable risks of labour will no longer be justified'*. As Steer states, this would remove selection pressures limiting foetal size, and the average birth weight and head size would no longer be restricted by pelvic size, creating in time a situation in which Caesarean birth could become a necessity for all women. In his view, CS would in this way facilitate the continued development of human intelligence by allowing brain size to increase yet further. Steer here is assuming a positive correlation of brain size with intelligence, which does not accord with what is observed in

nature; a whale, for instance, has a relatively larger brain than a human. A Caesarean is already the only way of birth for certain pedigree dog breeds, notably the bulldog, which now commonly requires to be delivered of its large-headed puppies by elective CS.<sup>37</sup>

Rather than exploring ways of making the human race reliant on specialist technology to facilitate its existence, should we not be spending more time exploring ways of facilitating more vaginal birth? Or are developed societies prepared to travel further in this direction of evolution, eventually losing the ability to give birth spontaneously, to what may prove to be a dead end? Are attempts to provide 'what women want' simply a hollow mantra used by protagonists on both sides of the polemic? Could responsible practitioners be in danger of misleading the public into thinking that somehow a Caesarean is 'natural'? In 2008, while maternal mortality reached massive rates in the developing world, some obstetricians, under the impression that 'what women want' – i.e. a Caesarean birth – is best, were describing '*the natural caesarean: a woman centred technique*',<sup>4</sup> which facilitates skin to skin contact at birth and may become feasible as elective CS. The publication of the article describing the technique was accompanied by a warning from the journal editor that it had not been evaluated; one has to wonder how the article came to be published at all. At a time of increased austerity, rising CS operations and fewer midwives, which may lead to more CS on grounds of safety, is elective CS going to be sustainable, and is it actually safe?

Rather than concentrating on 'naturalising' CS, perhaps normalising vaginal birth and publishing its benefits would be more appropriate, in which case some of the work of earlier obstetricians and radiographers could be used to support evidence-based midwifery practice in the labour ward more fully. This could be done, for example, by embracing the classic work of Russell<sup>38</sup> on the effect of birthing position on pelvic dimensions, supported more recently by Michel et al.'s work on the advantages of squatting in childbirth<sup>39</sup> – a posture that is also considered to offer physiological advantages in labour to mother and foetus. Observational studies of indigenous 'primitive' societies suggest that some Canadian Inuits and Australian aboriginal communities have very quick and easy births, though this has been attributed to local environmental factors, which if altered appeared to affect their natural abilities.<sup>34</sup>

Various other reporters in the past have strongly linked environment with birthing capability, and perhaps we need to revisit the work of Dr Kathleen Vaughan in India in the 1930s, who suggested a strong relationship between living style, diet and pelvic brim shape and the value of the squatting position, so alien in the West, to assist outlet expansion. While in India, she observed the power and influence of culture over natural selection. Mothers from the poorer classes, who often performed strenuous agricultural work outside in the fields, appeared to have quicker and easier labours than upper-caste women confined to the house by the custom of purdah. Vaughan concluded that the three essentials for normal birth were a round-brimmed pelvis, flexible pelvic joints and a natural posture.<sup>40</sup>

In Britain in the early 20th century, those working outside on farms or along the canals, and rural 'tinkers' and 'gypsies', also experienced easier births than the city dwellers of north-west England, Edinburgh and Glasgow, and appeared not to suffer from dystocia.<sup>41</sup> During the 19th and early 20th centuries, many obstetricians pondered the variety of pelvic shapes and sizes and compiled large sets of measurements, searching for racial differences. It was noted that, whereas the European and Russian female pelvis was flattened with a wider transverse diameter, the most effective shape was rounded, maximising the available space for foetal egress, suggesting that '*the more primitive the habits of life the more circular the pelvis*', and also noting that '*perfect teeth are found with a round pelvis*'. In England and America, '*poor diet, lack of light and rickets were recognised precursors to pelvic distortion and the chief causes of dystocia*'.<sup>40,41</sup>

### Conclusion – Back to the Future?

In terms of survival of the fittest, man has relatively few competitors, except other humans and a changing environment. The escalating rate of CS is, to some extent, perpetuated by the increased need to repeat the operation in future pregnancies, and technology has increased the need to perform emergency operations for foetal distress in women who might otherwise have been capable of a vaginal birth, putting them at increased risk in future pregnancies.<sup>4</sup> Roy suggests that the most likely cause of dystocia today, which has not emanated from technical innovation, is related to the '*overabundant nutrition and reduced levels of activity provided by our modern society*'.<sup>34</sup> Obesity in women of reproductive age and excessive weight gain in pregnancy are new risk factors for CS and perinatal adverse outcomes, including macrosomia.<sup>42,43</sup> Also, childhood rickets is returning to the UK,<sup>44</sup> which, if it were allowed to progress, could jeopardise a woman's birthing ability.

A threat to the sustainability of a high CS rate in England and Wales appears to be its cost, in a climate of economic downturn, with a shortage of midwives and a rising birth rate. Perhaps more effort could be focussed upon simple ways of promoting normal birth by ensuring that women, midwives and obstetricians all have a positive attitude towards it. The public health message would appear to be that, in order to maximise opportunities for women to give birth normally, a greater promotion of health and fitness in schools and a critical review of food production, marketing, selection and consumption are required. The promotion of normal birth would also benefit from more medical support and positive media coverage.

In a global sense, despite the untenable cost of maternal mortality, especially in the developing world, *Homo sapiens* has been successfully reproducing for thousands of years. If we become so dependent on a specialist environment and the use of technology for successful reproduction, could *Homo sapiens* ever be in danger of extinction? In the event of a major world war, extensive crop failure and famine, or other infrastructure collapse, women who were still capable of vaginal birth might become our 'peppered moths' and help our species to survive. ■

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