THE ASSOCIATION BETWEEN FETAL POSITION AT THE ONSET OF LABOUR AND BIRTH OUTCOMES

by

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A thesis submitted to:
The University of Birmingham
For the degree of
DOCTOR OF PHILOSOPHY

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August 2011

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ABSTRACT

Fetal position throughout labour exerts considerable influence on labour and delivery, with a mal-positioned fetus during active labour known to contribute towards fetal and maternal morbidity. In response there is a move towards promoting the Left Occipito-Anterior (LOA) position at labour onset as optimal. It is thought that the LOA position encourages anterior rotation thus reducing the likelihood of mal-rotation.

A systematic review was undertaken which highlighted an absence of scientific evidence. A prospective cohort study was therefore conducted with 1250 nulliparous women who were scanned to accurately determine fetal position, specifically the LOA position at the onset of labour and the association with delivery mode and other birth outcomes was examined.

The LOA position at the onset of labour was not associated with mode of delivery, nor were any of the other positions (p=0.39). Pain relief, labour duration, augmentation, and Apgar scores did not show any association with the LOA or other positions. The only association found was that women with a fetus in the posterior position were more likely to use pethidine (p=0.008).

This study has shown that the LOA fetal position at labour onset was not associated with improved outcomes and therefore should not be promoted as optimum.

DEDICATION

Dedicated to Dr Heather Winter (1959-2007) whose inspiration remained with me throughout my time spent on this work.

Dr Heather Winter supervised this work as my second supervisor for almost 3 years and provided invaluable advice and support. Dr Winter died in November 2007 from ovarian cancer, which had been diagnosed 10 years ago. During the period Dr Winter spent supporting my research I was unaware of her illness, highlighting the generosity she portrayed towards the support of others.

Dr Winter's knowledge in obstetrics, gynaecology and public health guided my research and was closely linked to her own work of interest, that being improving the health of mothers in particular those living in adverse circumstances.

For me, Dr Winter was a realist, and during the period when my research was not achieving its planned targets, it was the words and realism that such was not good enough that drove the successful completion of what is, 'our' work.

Thank you.

ACKNOWLEDGEMENTS

With thanks to my supervisors Professor Christine MacArthur, Professor Khalid Khan and Dr Heather Winter for their patience, persistence and their invaluable support. Thanks to Alice Sitch for providing me with her time and statistical support which made data analysis possible.

Sincere appreciation to the sonographers at the Birmingham Women's Hospital who helped train and assess the midwives involved. The Royal College of Midwives, Birmingham Women's NHS Foundation Trust, West Midlands NWAHP and Mothercare for their support with funding.

Jenny Henry who made changes happen and her continued support and belief in the importance of midwifery research. Sara Webb, Bernadette Early and Salma Hussain whose friendships and support proved invaluable. Angela McBennett, Stephanie Caves and Bernadette Early for their persistence and hard work in achieving the required scans. To all the women and midwives for their participation and for whom this study was done.

And finally, my husband Shafiq Ahmad who supported me patiently and to whom I have a lot of lost time to make up.

Thank you.

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LIST OF ABBREVIATIONS

APOLLO	Analysis of fetal Position at the Onset of Labour and Labour Outcomes
ARM	Artificial Rupture of Membranes
BMI	Body Mass Index
BWHCT	Birmingham Women's NHS Foundation Trust
CI	Confidence Intervals
CS	Caesarean Section
DOA	Direct Occipito-Anterior
DOH	Department of Health
DOP	Direct Occipito-Posterior
DspA	Direct spine Anterior
DspP	Direct spine Posterior
FD	Forceps Delivery
GA	General Anaesthetic
Hrs	Hours
IUD	Intra-Uterine Death
Kg	Kilograms
LOA	Left Occipito-Anterior
LOL	Left Occipito-Lateral
LOP	Left Occipito-Posterior
LspA	Left spine Anterior
LspL	Left spine Lateral
LspP	Left spine Posterior
MeSH	Medical Subject Headings

Mins	Minutes
NCT	National Childbirth Trust
NICE	National Institute for Health and Clinical Excellence
OA	Occipito-Anterior
OFP	Optimal Fetal Positioning
OL	Occipito-Lateral
OP	Occipito-Posterior
OR	Odds Ratio
OT	Occipito-Transverse
POP	Persistent Occipito-Posterior
R/LOT	Right/Left Occipito-Transverse
ROA	Right Occipito-Anterior
ROL	Right Occipito-Lateral
ROP	Right Occipito-Posterior
RR	Relative Risk
RspA	Right spine Anterior
RspL	Right spine Lateral
RspP	Right spine Posterior
SD (*sd)*	Standard Deviation
SVD	Spontaneous Vaginal Delivery
TENS	Transcutaneous Electrical Nerve Stimulation
UK	United Kingdom
US	United Stated
VD	Ventouse Delivery
WHO	World Health Organisation
WM NMAHP	West Midlands Nursing, Midwifery and Allied Health Professionals

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INTRODUCTION

There has been over the past few decades a decline in the rate of spontaneous vaginal birth and an increase in the inability of women to give birth without medical management and intervention (Savage, 2007). This has resulted in an increase in both operative vaginal and abdominal delivery rates. In an attempt to limit such interventions and associated morbidity various approaches to the management of care are being implemented. One such approach proposed by Jean Sutton which is gaining acceptance amongst maternity associated organisations is fetal positioning at labour onset, this is thought to increase the rates of Spontaneous Vaginal Delivery (SVD). The underlying relationship however, between fetal position at labour onset and associated outcomes is not properly understood. The author met with Sutton at a 'normal birth' conference, and considered that the theory should be further investigated. The author then studied the theory in depth and attended many of the conferences and presentations performed by Sutton; at times the author presented Sutton's theory at alternative conferences in order to debate the plausibility of the theory. The general opinion and criticism was clearly based on the lack of scientific evidence.

This thesis therefore examined the association between fetal position at labour onset and mode of delivery to asses specifically the theory of Optimal Fetal Positioning (OFP) as devised by Jean Sutton. OFP advocates the use of maternal exercises to manipulate the fetus into the Left Occipito-Anterior (LOA) position as the fetal position considered optimum for achieving SVD (Sutton, 2007). Sutton considers that this provides an explanation to the decreasing rates of SVD and offers OFP as a solution to the observed problems (Sutton, 2001).

A large prospective cohort study was performed to investigate the influence of fetal position at the onset of labour on delivery outcomes supported by a systematic review of the literature.

CHAPTER 1

BACKGROUND

1.1. Normal Obstetric Labour

The complete process of labour and delivery in the main defines the physiological transition from intra-uterine to extra-uterine life for the fetus, and from pregnant women to mother for the labouring female. The knowledge of normal labour as a physiological event is primarily based on the 18th century contributions of Fielding Old, William Smellie and Solares de Renhac (Dietze, 2001). This is largely due to the ethical issues associated with replicating the work they undertook, and has consequently resulted in our understanding of labour mechanism as we know it today. Mechanism of labour as understood and depicted in many textbooks is described as essentially a mechanical process, whereby the fetus is expelled from the uterus with the aid of uterine contractions (Tiran, 2008, McCormick, 2008). The fetus has always been described as an active participant that must undergo a series of intricate movements as it descends into the maternal pelvis.

The process of birth is underpinned by the position of the fetus and the movements it adopts in order to birth spontaneously. Fetal position is defined as the relationship of a particular landmark of the fetus, which in the normal instance is the fetal occiput, in relation to the landmarks of the female pelvis (Akmal and Paterson-Brown, 2009). Labour mechanism is mapped according to this relationship and is how the process of normal labour is described. The processes of labour mechanism is however complex and may give rise to many points at which deviation from the norm may arise.

To give birth spontaneously the fetus must undergo five distinct movements during the process of labour and delivery as it passes through the maternal pelvis (Caruthers, 2000). The five movements (McCormick, 2008, Caruthers, 2000, Cunningham et al., 2008) are recognised as:

- Descent
- Flexion
- Internal rotation
- Extension
- External rotation

1.1.1. Descent

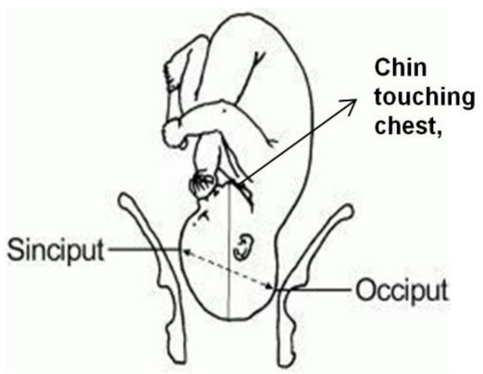
The fetus begins its journey with descent in order to achieve engagement of the presenting part into the true pelvis which commences at the pelvic brim or pelvic inlet (Selman and Johnston, 2010). The description of mechanism of labour is depicted with engagement taking place when the transverse diameter of the fetal head has passed through the transverse diameter of the pelvic brim (McCormick, 2008, Tiran, 2008). This suggests that engagement only takes place in the transverse plane as it is where the widest pelvic diameter is available for the widest part of the fetal head (Fig. 1.1).

Figure 1.1. Decent and engagement in the transverse position (Faulkner, 2009).

1.1.2. Flexion

This is followed by flexion, which takes place whilst decent into the mid-cavity of the pelvis is occurring (Caruthers, 2000). Complete flexion is achieved when the fetal chin is resting on the fetal chest. By achieving complete flexion, the fetal occiput becomes the leading part ensuring that the smallest diameter of the fetal head is leading (Selman and Johnston, 2010). The position of the fetal head remains in the transverse plane during the process of descent and flexion (Fig 1.2).

Figure 1.2. Complete flexion of fetal head (Mathai et al., 2000)



1.1.3. Internal rotation

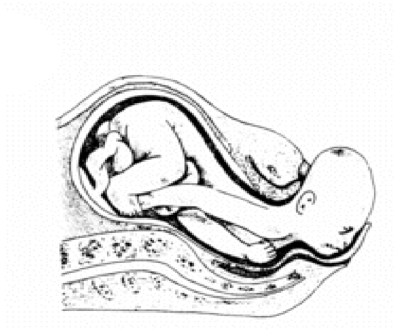
Flexion is then followed by 90° internal rotation of the fetal head, which takes place between the mid-cavity and pelvic floor (McCormick, 2008). During this stage the fetal head assumes an oblique or in the majority of cases an anterior posterior position, ready for the expulsive phase of labour (Fig. 1.3) (Dietze, 2001).

Figure 1.3. Complete internal rotation to anterior posterior position (Faulkner, 2009).

1.1.4. Extension

As the fetal head reaches the pelvic floor, extension of the fetal head commences along the sacral curve (McCormick, 2008, Caruthers, 2000). The fetal chin no longer rests on the fetal chest and instead it extends as movement along the perineal body achieves delivery of the fetal head (Fig. 1.4).

Figure 1.4. Extension and delivery of fetal head (Faulkner, 2009).



1.1.5. External rotation

The final stage is external rotation whereby the fetal head returns to the transverse position encouraging decent and rotation of the shoulders to the anterior-posterior orientation (Dietze, 2001, Selman and Johnston, 2010). This completes the fetal manoeuvres and spontaneous delivery of the fetus is usually achieved following a few further contractions.

Consensus remains, amongst the midwifery and obstetric profession, that fetal position throughout labour and delivery exerts considerable influence on the actual process of labour and outcomes for both the mother and the neonate (Cunningham et al., 2008, McCormick, 2008). In the majority of cases the fetus presents by the head, specifically in the Occipito-Anterior (OA) position which is considered the best structural fit through the maternal pelvis (Chamberlain and Steer, 1999). This is reflected in the normal mechanism of labour that portrays the OA position as the normal position for the fetus to assume. Table 1.1 summarises the process of normal labour, describing the position of the fetus at each pelvic point.

Table 1.1: Fetal position in relation to pelvic cavity during normal labour

Pelvic point	Fetal position
Pelvic inlet	Right/Left Occipito-Transverse (R/LOT)
Mid-cavity	Occipito-Transverse/Rotating (OT)
Pelvic outlet	OA

Normal labour mechanism as described, understood and depicted in the current obstetric and midwifery literature assumes that the OA position is the 'normal' position for the fetus. The fetal occiput however, may not always present in the OA position, but may also present and persist or arrest in the posterior or transverse position. This is considered incorrectly positioned and is referred to as fetal mal-position

1.2. Fetal Mal-position

Mal-position is when the fetal occiput is directed towards the posterior quadrant of the maternal pelvis (Tiran, 2008). The most frequently encountered mal-position is the Persistent Occipito-Posterior (POP) fetal position and is thought to be the most common complication encountered during labour and delivery (Coates, 2002). POP position is considered to occur in 10-20% of labours at onset and 5% at delivery (Gardberg et al., 1998, Akmal et al., 2004c, Sizer and Nirmal, 2000, Ponkey et al., 2003). Studies that distinguished between nulliparous and multiparous women reported increased incidences at both labour onset an delivery in nulliparous women (Ponkey et al., 2003). Ponkey et al. (2003) reported that the incidence of Occipito-Posterior (OP) deliveries in nulliparous women (7.2%) were almost double compared to multiparous women (4.0%).

The cause of fetal mal-position remains unclear with the most plausible explanations being physical inhibitors and mechanistic deviation. It is thought that pelvic types may predispose fetuses to adopt a posterior fetal position, particularly those that have a narrowed fore-pelvis or a flat sacrum such as the android and anthropoid pelvises (Sweet, 1997). It is also argued that a de-flexed fetal head may cause mal-position (Coates, 2002). Some studies have shown that an anterior positioned placenta may contribute towards a posterior fetal position, although other studies have not reported similar findings (Gardberg and Tuppurainen, 1994). The most common rationale is that of mechanical deviation, where mal-rotation is thought to be the primary cause of mal-position or a POP fetal position (Chamberlain and Steer, 1999). The reasons as to why some fetuses adopt the posterior position remains unclear and it maybe that no single cause explains the reason for mal-position with varying characteristics predisposing fetuses to the posterior position.

The posterior fetal position is understood to be the less favoured position as the process of labour and delivery is often challenged with varying clinical complications. Once engagement has taken place in the posterior rather than the OA position, labour mechanism is altered from the point of labour onset (Gardberg et al., 1998). For the posterior fetus to engage it must do so with a deflexed head, unlike the OA position which engages in the flexed position. In the OP position the maternal spine acts as an inhibitor preventing the head from flexing sufficiently to allow the chin to rest on the chest (Selman and Johnston, 2010). The OA position achieves this with ease and ensures that the smallest diameter of the fetal head becomes the leading part. In the OP position the lack of flexion encourages the largest diameter of the fetal head to present and descend as the presenting part (Faber, 1998). The deflexed head with the larger diameter does not fit the pelvis well or position itself centrally over the cervix (Biancuzzo, 1993). Since the deflexed head of the OP fetus rests anteriorly over the cervix rather than resting centrally, contractions are not effectively stimulated. In turn this causes poor uterine activity that leads to both delayed descent and uneven and slow cervical dilatation (Chamberlain and Steer, 1999, Selman and Johnston, 2010).

Eventually, when cervical dilation is achieved the increased diameter of the presenting part is 2.5cm larger and to achieve vaginal delivery the fetal head must mould significantly and the perineum must stretch more than is necessary with an OA positioned fetus (Coates, 2008). This then increases the need for operative delivery and causes greater perineal trauma (Benavides et al., 2005).

The mechanism of the OP fetus is based on theory as to what ‘may’ happen when the anatomy and physiology of the OP fetus is considered. No scientific evidence exists on the posterior mechanism of labour. Scientific evidence does however exist in relation to both the maternal and fetal morbidity associated with a posterior fetal mal-position compared to the favoured OA fetal position. It is thought that morbidity is associated with the interventions that become necessary in order to salvage the process and achieve a safe delivery when the fetus persists in the OP position (Ridley, 2007).

1.3. Maternal and Fetal Outcomes Associated with Occipito-Posterior Mal-position

The process of labour and delivery involves the fetus adopting intricate movements as it descends the maternal pelvis. The movements the fetus adopts are vital if SVD is to be achieved, in the OP fetus the direction of movement is altered giving rinse to mal-rotation resulting in less favoured outcomes. A number of studies have investigated maternal and fetal outcomes associated with the OP position.

Sizer and Nirmal (2000) conducted a study of 16,781 nulliparous women at term gestation, with singleton cephalic fetuses during the period of 1990-1998. The study was a retrospective review of health records to determine if there were differences in obstetric outcomes between the OP and the OA deliveries, the main outcomes being mode of delivery and Apgar scores at 5 minutes. Secondary outcomes were maternal age, induction, epidural use, augmentation by oxytocic drugs and neonatal birth weight (Sizer and Nirmal, 2000). OP was defined as delivery of 'face-to-pubes' and delivery where rotation of an OP to an OA position was undertaken prior to delivery. The frequency of the OP position at delivery was 4.7%. Mode of delivery associated with fetal position was significantly different, the rate of SVD for women who delivered an OA fetus was 61.8% and 14.6% for those who delivered an OP fetus (p=0.001). The instrumental delivery rate was 24.4% for the OA group and 43.7% for the OP group (p=0.001) and the emergency CS rate for the OA group was 13.7% compared to 41.7% for the OP group (p=0.001). Sizer and Nirmal (2000) also found an increased association between the use of epidural analgesia in labour and oxytocic augmentation of the OP fetus, apgar scores at 5 minutes (<8) were not significantly different and nor were increasing maternal age, induction of labour and gestational age. Sizer and

Nirmal's (2000) study suggested that delivery in the OP position was associated with increased morbidity for the mother although not for the neonate.

Pearl et al. (1993) conducted a study in the United States (US) to investigate the association between OP delivery and maternal and fetal morbidity using a larger number of neonatal outcomes than the previous study (Pearl et al., 1993). The study was retrospective and compared 564 vaginal OP deliveries with 1068 OA controls matched for race, parity, delivery method and neonatal birth weight. Computerised patient medical databases were used to obtain data on maternal and neonatal outcomes, including delivery mode. Pearl et al. (1993) did not outline specifically how position of the fetus was determined but since retrospective review of medical records were used it is presumed that position documented by the attending clinician at delivery was used. The OP position at delivery was found to be associated with a longer second stage of labour despite fetuses being matched for equivalent birth weight ($p<0.05$) and an increased incidence of episiotomy and severe perineal lacerations that extended to include third and fourth degree perineal lacerations ($p<0.05$). Blood loss following delivery was also increased, and women who had OP deliveries had longer hospital stays compared to women who had OA deliveries ($p<0.05$) (Pearl et al., 1993). Neonates who had operative deliveries in the OP position were more likely to suffer from facial nerve and Erb's palsy ($p<0.05$). The overall rates of facial nerve and Erb's palsy were 1.3 and 0.3 per 1000 live births, but OP fetuses were examined 12.4 and 5.3 per 1,000 live births. Despite this and the OP fetuses having a higher frequency of fetal distress, Apgar scores, cord gas pH and neonatal intensive care admissions were no different from the OA group (Pearl et al., 1993).

The study concluded that delivery of the OP position per se was associated with increased maternal morbidity. Increased fetal morbidity for the OP position was associated with operative OP delivery (Pearl et al., 1993).

The study highlighted important information relating to fetal malposition, however the generalisability of the study to the population in the United Kingdom (UK) is uncertain since the medical system and practices in the US vary considerably from those in the UK. Certain findings that were reported may be linked or at the very least influenced by the obstetric practices in the US, rather than sole association with fetal OP positioning.

The increased incidence of episiotomy and severe perineal trauma in the form of anal sphincter and rectal tissue damage may be related to the preferred choice of instrument in the study population which was said to be the forceps (Pearl et al., 1993). 76% of the instrumental deliveries in the study were forceps deliveries with only 24% of deliveries being ventouse. Forceps deliveries are generally associated with increased perineal trauma, need for episiotomy and neonatal injury comparative to other forms of vaginal delivery (Johanson and Menon, 2009). Comparatively in the UK, ventouse is now the favoured choice of instrument rather than the forceps (Johanson and Menon, 2009). The second difference is the type of episiotomy performed, which in the UK is usually medio-lateral which are less likely to extend and cause further trauma (Downe, 2008). In Pearl et al.'s (1993) study the vast majority of women had median episiotomies which are more likely to extend and cause third and fourth degree tears (Downe, 2008). It is, therefore difficult to draw firm conclusions and generalise the study findings to the UK population.

Fitzpatrick et al. (2001) undertook an observational study in Ireland comparing outcomes of 246 women with POP positions at delivery with 13,543 vaginal deliveries of OA positioned fetuses. They found that the incidence of the OP position at delivery was 1.8% overall, 2.4% in nulliparous and 1.3% in multiparous women. Position was defined as that observed at delivery or that diagnosed on vaginal examination prior to delivery by the attending clinician (Fitzpatrick et al., 2001). The study found that significantly more women in the OP group had a prolonged pregnancy ($p<0.01$) and were more likely to be induced compared to the OA group ($p<0.001$). They also found that the use of oxytocic drugs to augment labour was significantly higher in the OP group than the OA group (52% vs. 32%, $p<0.001$) and prolonged labour of greater than 12 hours was more common amongst the OP group (12% vs. 1.7%, $p=0.001$). The rates of both instrumental delivery and operative delivery were significantly higher in the OP group than the OA group ($p<0.001$). The SVD rate for the OA fetuses was 84% overall (inclusive of nulliparous and multiparous women) whilst the SVD rate for the OP fetuses was 29% in nulliparous and 55% in multiparous women ($p<0.001$).

Fitzpatrick et al.'s (2001) study suggested a significant increase in maternal morbidity associated with the OP position at delivery. Maternal perineal trauma was significantly more common in the OP group than the OA group in both the nulliparous and multiparous women ($p<0.001$). Although the incidence of episiotomy was similar in both OA and OP groups, the OP group had significantly greater risk of anal sphincter injury following instrumental delivery ($p<0.001$). Neonatal condition at delivery was similar in both the OA and the OP groups, showing no difference in the Apgar scores.

There are, however, limitations to Fitzpatrick et al.'s (2001) findings including the potential for misclassification bias as the study relied on reported position at delivery by the attending clinician. Nonetheless, previously discussed studies used the same method to determine position so a similar criticism of those studies would be justified. In Fitzpatrick et al.'s (2001) study position, in some cases, was identified by vaginal examination prior to delivery. This is despite reported criticism with the associated inaccuracy of digital vaginal examination to determine fetal position (Akmal et al., 2003). Furthermore the institution in which the study was carried out followed an active management policy for nulliparous women but not for multiparous women. This may suggest that some of the differences reported between the nulliparous and multiparous groups may actually be influenced by labour management and not OP positioning. Although the study by Fitzpatrick et al. (2001) has drawn strong conclusions, it has identifiable flaws that must be considered when interpreting and applying the findings.

Ponkey et al. (2003) conducted a retrospective cohort study including 6434 consecutive, term, cephalic, nulliparous and multiparous women and compared maternal and neonatal outcomes of those delivered in the OA position against those who delivered in the OP position.

Ponkey et al. (2003) found the rate of OP fetuses at delivery for nulliparous women was almost double compared to multiparous women (7.2% vs. 4% $p<0.001$), concluding that OP position at delivery was more common in nulliparous women. Further significant differences between the OA and OP groups were:

- Prolonged first stage (48.3% OP vs. 30.3% OA, $p<0.001$).
- Prolonged second stage (53.3% OP vs. 18.1% OA, $p<0.001$).
- Increased oxytocin augmentation (48.9% OP vs. 36.8% OA, $p<0.001$).
- Increased use of epidural analgesia (86.1% OP vs. 73.1% OA, $p<0.001$).
- Chorioamnionitis (4.7% OP vs. 1.1% OA, $p<0.001$).
- Assisted vaginal delivery (24.6% OP vs. 9.4% OA, $p<0.001$).
- Caesarean delivery (37.7% OP vs. 6.6% OA, $p<0.001$).
- Third and fourth degree perineal laceration (18.2% OP vs. 6.7% OA, $p<0.001$).
- Excessive post partum blood loss (13.6% OP vs. 9.9% OA, $p<0.03$).
- 1 minute Apgar score less than 7 (12.4 % OP vs. 7.1% OA, $p<0.001$).

The study however did not find low Apgar scores at 5 minutes to differ between the OA and the OP groups. Furthermore when the analysis was performed separately for nulliparous and multiparous women, duration of second stage, epidural use and mode of delivery were the only outcomes that remained significantly different between the OA and OP groups amongst multiparous women. For nulliparous women differences for all the outcomes remained significant, suggesting that the OP position for nulliparous women was more likely to be associated with resulting morbidity (Ponkey et al., 2003).

The limitation of this study is that it was conducted in the US, where as stated earlier, practice is different to that in the UK. Furthermore the retrospective review of medical databases gives rise to issues of data verification whereby the accuracy of the data cannot be determined.

Senecal et al. (2005) undertook secondary analysis from data gathered for a randomised controlled trial for delayed and early pushing with epidural analgesia in order to assess the effect of fetal mal-position on second stage progress amongst nulliparous women. Position at delivery was taken as that documented by the attending clinician at delivery. A total of 1608 women were included in the analysis and fetal position was categorised into 3 groups, OA, OP and OT. They found no association between fetal position and gestational age and duration of first stage of labour or the use of episiotomy, but did find an association between OP position at delivery and increased incidence of the following compared to the OA and OT position:

- Oxytocic augmentation ($p<0.001$)
- Longer second stage duration ($p<0.001$)
- Postpartum blood loss greater than 500mls ($p<0.002$)
- Third and fourth degree perineal trauma ($p<0.001$)
- Caesarean delivery ($p<0.001$)
- Mid-cavity assisted vaginal delivery ($p<0.001$)

Neonatal outcomes including low Apgar, abnormal umbilical cord gasses, admission to intensive care were not associated with an OP position (Senecal et al., 2005).

What appears consistent in most studies is that the OP position is associated with increased rates of caesarean delivery, instrumental delivery and perineal trauma in the form of third and fourth degree lacerations (Pearl et al., 1993, Senecal et al., 2005, Ponkey et al., 2003, Fitzpatrick et al., 2001).

Obstetric anal sphincter injury affects 8-18% of women which may lead to incontinence or associated symptoms creating a debilitating condition (Benavides et al., 2005). Benavides et al. (2005) conducted a retrospective cohort study to compare the incidence of perineal trauma in OA and OP forceps assisted vaginal deliveries. The primary outcome was the occurrence of third and fourth degree perineal lacerations and the position of the fetal head was that as documented in the delivery notes, classified into OA or OP. For cases where rotational forceps were used, position was defined as the position after rotation was completed. A total of 588 forceps deliveries were analysed and it was found that 35% of forceps-assisted vaginal deliveries resulted in either a third or fourth degree perineal laceration. Interestingly however, the majority of forceps deliveries were performed from an OA position and not from an OP position (88.4%, 11.6%). Despite this, perineal trauma linked with anal sphincter damage was significantly associated with the OP position at delivery (OP 51.5% vs. OA 32.9% p=0.003). To further determine if the OP position was an independent risk factor for anal sphincter damage, Benavides et al. (2005) applied a logistic regression model to control for known confounding variables. The OP position was 3.1 times more likely to be associated with anal sphincter injury, concluding that the OP position was independently associated with such damage (Benavides et al., 2005).

Wu et al. (2005) undertook a similar study to compare the incidence of anal sphincter damage between OA and OP positioned fetuses in 393 vacuum assisted deliveries. The rate of third and fourth degree perineal lacerations in this group was 24.4% overall and the OP group had a significantly higher rate of anal sphincter damage compared to the OA group (41.7% vs. 22%, p=0.003). Wu et al. (2005) also undertook logistic regression analysis which demonstrated that OP was 4 times more likely to be associated with anal sphincter injury compared to OA position.

Studies investigating OP positioned deliveries clearly suggest that adverse maternal outcomes from an OP positioned fetus at delivery are increased. The specific areas that are consistent include:

- Decreased incidence of SVD and increased incidence of instrumental/operative delivery (Ponkey et al., 2003, Sizer and Nirmal, 2000, Pearl et al., 1993, Gardberg et al., 1998).
- Increased incidence of anal sphincter and rectal tissue damage (Benavides et al., 2005, Wu et al., 2005).

Implications on neonatal morbidity remain less conclusive. Cheng et al. (2006) conducted a retrospective study of women at term gestation with cephalic, live, singleton fetuses over a 26 year period. The study included the analysis of a total of 31,392 neonates. Position of the fetus was determined at delivery by the attending clinician, and categorised into OA or OP position with OT position excluded. The outcomes investigated to determine association between OP position and neonatal morbidity were Apgar score <7 at 5 minutes, umbilical cord gasses (pH < 7 and base excess ≤-12), Meconium stained liquor, Meconium aspiration and admission to intensive care.

The study found that the prevalence of the OP position at delivery was 8.2% overall, with nulliparous women having an increased prevalence compared to multiparous women (10.3%, 6%). The results in relation to the outlined neonatal outcomes were as follows:

- OP position had significantly more neonates with Apgar scores <7 at 5 minutes (3.8% OP, 1.9% OA, p<0.001).
- OP position had a higher rate of umbilical cord gasses pH < 7 and base excess below -12 (1.8% OP, 0.5% OA, p<0.001).
- Meconium stained liquor was more common in the OP group (32.3% OP, 22.7% OA, p<0.001)
- Meconium aspiration was more common in the OP group (1.2% OP, 0.7% OA, p<0.001).
- Admission to intensive care was higher for the OP group (10.7% OP, 6% OA, p<0.001).

Further analysis to control for confounding was undertaken and all the above differences remained statistically significant. To examine association between neonatal morbidity and maternal parity the analysis was then stratified by parity revealing that in both the nulliparous and the multiparous groups the OP position still had significantly higher rates of undesirable outcomes for the neonate (Cheng et al., 2006). The study concluded that neonates in the OP position compared to those born in the OA position were associated with an increased risk of short term neonatal morbidity. Cheng et al. (2006) considered that previous studies had not observed similar differences due to a lack of statistical power rather than an absence of association and that their large sample allowed these associations to be identified.

The association of maternal and neonatal morbidity with fetal malposition is apparent from the studies reported. What is thus becoming evident is that increasing rates of intervention are necessary to manage the associated risk of morbidity. Interventions however are also associated with varying degree of risk and consequently such is being debated as to the appropriateness of use.

1.4. The Rising Rates of Intervention

The interventions used in everyday obstetrics have generated many debates as to the cause and perceived advantages of such interventions and the increasing rates of use (Sharma et al., 2009). The greatest debate has been that of the rising caesarean section (CS) rate, as the associated morbidity and mortality for the mother and the neonate is well acknowledged (NICE, 2004). CS is known to be associated with increased:

- Abdominal pain
- Bladder injury
- Urethral injury
- Need for further surgery
- Hysterectomy
- Uterine rupture
- Maternal death
- Ante partum stillbirth
- ITU/ HDU admission
- Thromboembolic disease
- Increased duration of hospital stay
- Readmission to hospital
- Placenta previa
- Not having more children
- Neonatal respiratory morbidity

Furthermore, during the triennium of 1997-1999 the fatality rate of direct deaths following caesarean delivery was almost five times greater than for vaginal delivery and twelve times greater for emergency caesarean delivery, thus highlighting the severity of risk associated with CS (DOH, 2000).

The proportion of SVD births has fallen steadily from 78% in 1989 to 66% in 2004-2005 (DOH, 2005). Concurrently the rate of CS deliveries has continued to increase from a rate of under 3% in the 1950's, 9% in 1980, to 12% in 1990 followed by a rapid increase to 21% in 2000 (DOH, 2002). The CS rate has increased steadily further to a level of 24.8% (DOH, 2010). Reasons for the increasing rates of CS delivery remain undetermined although some medical and non-medical reasons have been highlighted (Table 1.2).

Table 1.2: Reasons for CS delivery (Hamilton, 2009)

Medical indication	Non-Medical indication
Clinician management	Culture and organisation
Elective CS safer for breech fetuses	Maternal choice
Increasing use of IVF	Litigation
Increasing proportion of older mothers	
Advances in surgical techniques	

In response to ongoing concerns over the rising CS rate the World Health Organization (WHO) published a recommendation suggesting a safe CS rate of 10-15% (WHO, 1985). The Department of Health (DOH) also commissioned the National Sentinel Audit, carried out by the Royal College of Obstetricians and Gynaecologist in 2001 with the aim to obtain accurate data in order to understand reasons behind the CS rate and respond accordingly. This audit found that 63% of CS's were emergency and 37% were elective, with the main indications cited for emergency caesarean delivery being presumed fetal distress (22%) and failure to progress/labour dystocia (20%) (Thomas and Paranjoty, 2001). Despite being listed as the second most commonly cited indication for delivery by emergency CS failure to progress/labour dystocia is not in itself a diagnosis but an indicative symptom of a potentially undiagnosed complication. It is unlikely that a medical complication would be disguised as failure to progress since the majority of women who give birth have a normal, healthy and uncomplicated pregnancy. Therefore it would be more probable to suggest that fetal mal-position may be an influencing factor since OP associated morbidity and increasing rates of operative delivery appear to correlate with indications such as failure to progress.

Specifically Fitzpatrick et al. (2001) concluded from his study of persistent OP delivery that the main indication for CS delivery was dystocia which accounted for 78% of OP deliveries compared to 40% of OA deliveries. Ponkey et al. (2003) reported findings that OP fetuses had significantly longer first and second stages, again correlating with the main indication for caesarean delivery. Pearl et al. (1993) stated that the most frequently reported indication for operative delivery was fetal distress and prolonged second stage. Indeed, all studies that have investigated the effect of OP delivery on maternal morbidity have concluded that the rate of operative delivery, both CS and instrumental delivery, have been significantly greater in the OP group (Ponkey et al., 2003, Sizer and Nirmal, 2000, Pearl et al., 1993, Gardberg et al., 1998).

The increasing rates of operative delivery and the increasing morbidity for both the mother and neonate at a time when health care and general health is thought to be at a peak has urged professionals to seek to improve or curtail the rising rates of intervention. Maternity associated organisations are as a consequence seeking methods to restrict the rising rates of both intervention and operative delivery. Obstetricians are exploring 'active' management approaches to determine if early intervention in the form of amniotomy and/or oxytocin augmentation may reduce the rates of operative delivery (Smyth et al., 2009). However, such interventions are not without additional risk. The use of early amniotomy is associated with fetal heart rate abnormalities whilst oxytocin is associated with hyper stimulation and consequently fetal distress (Fraser et al., 2006). In an attempt to prevent low risk pregnancies from undergoing unnecessary intervention there is a move towards midwife-led care and birth units. In particular a steady trend within the Midwifery field has been observed which encourages alternative management to curtail the problem of dystocia.

Labour dystocia is a significant cause of operative delivery in emergency cases and the main indicator for the transfer of care and management from midwife-led to that of abnormal labour and consequently consultant-led care (Thomas and Paranjoty, 2001). Thus, it is this problem that most are attempting to solve as the consequences remain extensive. A theory, devised by Jean Sutton, a New Zealand based midwife claims to potentially overcome the morbidity associated with mal-position by implementing Sutton's theory of Optimal Fetal Positioning (OFP).

1.5. Jean Sutton's 'Optimal Fetal Positioning'

The theory of 'Optimal Fetal Positioning' (OFP) was devised by Jean Sutton, a New Zealand based midwife, now in her late 70s. Sutton's experience of childbirth started early as an aid at a local maternity hospital, following which she went on to train as a midwife working in a variety of hospital settings and childbirth education for over 30 years (Sutton, 2007). She established a background in maternity care, farming and engineering which she claims were all key factors that influenced and helped her understand and establish her theory of OFP. OFP is the term used by Sutton to describe the 'best possible position' for the fetus to adopt prior to labour onset (Sutton and Scott, 1996). This in turn, Sutton claims, increases the likelihood of SVD compared to all other positions that the fetus may adopt at the onset of labour.

Initially, Sutton claimed that the OA position was linked to improved outcomes relative to the OP fetus (Sutton, 2001, Sutton and Scott, 1994). She then went on to claim that it was specifically the LOA position that was the optimal fetal position and linked to improved outcomes and that the ROA position was linked to least favoured outcomes (Sutton, 2001, Sutton and Scott, 1996).

Sutton claimed that the LOA position is optimal as the gravid uterus at term gestation in the nulliparous women adopts a specific shape within the maternal abdomen. The distinct shape of the uterus encourages anterior rotation of an LOA positioned fetus during labour and therefore increases the likelihood of SVD (Sutton, 2001, Sutton and Scott, 1994). Sutton claims that the uterus in a first pregnancy lies with the fundus tilted to the maternal right and leaning anteriorly against the abdomen referred to as the 'right obliquity' of the term uterus (Sutton and Scott, 1996, Sutton, 1996, Sutton, 2001). The tilting of the uterus in this manner allows the LOA fetus to lie against the anteriorly inclining convexity of the uterus. Sutton claims that this encourages anterior rotation of the LOA fetus during labour thus reducing the possibility of mal-rotation to a posterior position (Sutton and Scott, 1996). Comparatively, the ROA and ROL positions are thought to be predisposed to mal-rotation. When the ROA position is assumed the fetus lies against the concavity of the uterus which is posteriorly inclined, thus lying towards the lumber region of the maternal spine (Sutton 2001). The lean towards the lumber region encourages mal-rotation of the fetus to a posterior position thus decreasing the likelihood of SVD. This is the fundament of Sutton's arguments and is used to explain why LOA position is the optimal fetal position.

The second characteristic of the uterus that Sutton claims supports the OFP theory is referred to as 'dextro-rotation' of the lower uterine segment, however this aspect of Sutton's theory is not explained well in any of her literature. In relation to this particular aspect Sutton writes; "The uterus will have assumed its final position tilted to the maternal right and turned slightly to the left at its base—(right obliquity and dextro-rotation of the textbooks)" (Sutton 2001, pg 36). There is no further explanation of dextro-rotation by Sutton, but what is understood from this is that the lower segment of the uterus assumes a twist at its base that is described by Sutton as 'turned slightly to the left' (Sutton 2001, p36). This base twist may direct the movement of the presenting part as it descends into the lower segment and onto the cervix. She claims that as the twist is angled from left to right, as the LOA fetus descends the occiput that is initially on the maternal left will be encouraged to rotate to the right, thus encouraging anterior rotation of the occiput when an LOA position is assumed. Comparatively dextro-rotation will encourage posterior rotation of the ROA position as an occiput that commences on the right will rotate posteriorly towards the left. This is depicted in Figure 1.5.

Figure 1.5. Dextro-rotation of the lower uterine segment (Faulkner, 2009).

Dextrorotation from left to right

Sutton's theory evolved further to explain the rising intervention and CS rates currently being observed, claiming that until the 1960's, 85% of fetuses presented in the LOA position at the onset of labour (Sutton, 2001, Sutton and Scott, 1996). It is unclear what source Sutton is using to support the statistics she reports, although it would appear that it is anecdotal evidence. Suttons understanding is that mal-position; particularly the OP position has increased 'drastically' in the last few decades and is the primary cause of current maternity statistics (Sutton, 2000, Sutton, 2001). The increase in intervention and operative delivery caused by the increase in fetal mal-position is attributed to the change in modern life style (Sutton and Scott, 1994). She describes Western lifestyle changes since 1960 as 'quite unlike any other' (Sutton 2001). The changing role of women from the household setting into the wider world where they assumed paid work has meant a decrease in physical activity. The use of the car, the introduction of comfortable sofas, the availability of labour saving devices such as washing machines and daily use of computers she considers have all encouraged a physical posture change in women (Sutton, 2007, Sutton, 2001). Women are now less likely to adopt forward leaning postures that encourage fetuses to adopt an OA position in-utero but instead adopt postures that are posterior inclining (Sutton 2001; Sutton 2000). It is these lifestyle changes that Sutton believes has led to the current figures of intervention and operative delivery caused primarily by posterior positioned fetuses (Sutton 2001).

Sutton's background in engineering and her theories of the birth process and consideration of the main problem led her to devise a programme of maternal posturing and movement. Such, she believed could encourage fetuses into the LOA position and lessen the increasing rates of intervention and operative delivery. The programme was devised based on the following 5 main points which aimed to encourage an LOA fetal position (Sutton, 2001, Sutton, 2007).

1. Understanding that from 34-36 weeks the fetus needs to establish its position for birth (i.e LOA). After this the fetus is too large to manoeuvre readily with the aid of maternal posturing.
2. From 34 weeks the mother should ensure that when possible her knees are lower than her pelvis and avoid activities such as using the car on a daily basis, going on long journeys and sitting on sofas that encourage slouching with raised knees above the level of the pelvis. The rationale for this is to allow available space at the pelvic brim so that the fetal head could engage and descend.
3. When resting women should try to lie on their left side, to encourage an LOA fetal position and engagement.
4. Women should aim to adopt forward leaning postures particularly when the fetus is active (Sutton, 2001, Sutton, 2007).
5. Discourage semi-recumbent positioning, deep squatting and late maternity leave for working mothers.

1.6. Evidence Underpinning OFP Theory

Jean Sutton promotes OFP as a theory that is supported by physiology using physiological and biological principles as the evidence to underpin OFP. Specifically she claims biological plausibility using anatomical evidence to define the 'plausible' relationship between biological factors of fetal position and uterine anatomy with the causal event of spontaneous vaginal delivery (Section 1.5). Sutton only provides an explanation supported by the laws of physics, i.e, that law of gravity states that all object are drawn to the earth and that movement is dependent on mass and availability of space (Gamow, 2003). That is the descent of the fetus is encouraged by uterine activity and the principles of gravity, yet direction of fetal movement is influenced by uterine anatomy that may dictate directional movement within the pelvic cavity.

As Sutton discusses the physiology underpinning OFP, it is these principles that form the scientific method to support her explanation as to why the LOA position is the optimum fetal position. It is such that underpins the evidence Sutton provides to support her theory and to those who refute her theory of whom there are many both published and unpublished, she claims that biological plausibility with anatomical evidence is suffice (Donna, 2008, Holman, 2001, Nolan, 1997, Coates, 2002). Sutton considers that it is the job of those who disagree to provide evidence to the contrary.

The author contacted and met with Sutton to obtain further evidence on the theories of OFP. Sutton explained in detail the anatomical and physiological relationships which underpinned her theory (outlined in section 1.5). The author requested additional evidence from Sutton who provided practice audits. Sutton had worked in several hospitals in New Zealand including the management of a single birth unit, and produced audits showing delivery outcomes for women delivering on her birth unit compared to a similar unit during the same period. Sutton claimed it was specifically routine practice for all parents planning on booking at her birth unit to attend education classes that taught the theory of OFP. She outlined this as the distinctive difference between associated units and her unit, yet the rates of CS, instrumental delivery and SVD rates were significantly different. Sutton claimed the SVD rate at her unit was 85%, and the remaining 15% accounted for operative abdominal and assisted vaginal deliveries. In Sutton's book she writes "85% of those who grew to full term got the exit message right that is, LOA.... About 5% are breech....10% chose Vertex ROP of these half would sort themselves out..... and only 5% would need help." (Sutton 2001, pg 12). Sutton informed me that the statistics she used in her book were those of the audit findings. The audits however were unpublished and as a consequence were not available during the period of thesis write-up.

Suttons theory as with all scientific theory forms the basis of many preliminary concepts, it is however the ability to test it that provides evidence to support or negate the theory in question.

1.7. OFP Theory and Acceptance

Jean Sutton has promoted her theory of OFP over a decade. Awareness and acceptance of Sutton's theory amongst a range of maternity-related organisations would appear to be extensive when an everyday search engine (Google) is used to search the theory of OFP and web associated affiliations. The word 'Optimum Fetal Positioning' resulted in 71 pages of associated links with 815,000 results. All 71 pages of results were viewed by the author of which, up until the final page, various direct links to the OFP theory were found. What was also interesting was the large number of active/natural birth and associated organisations promoting and implementing Sutton's theory, below is a list of few:

- NCT
- Homebirth UK
- Women's Health Physiotherapy
- Mountain View Midwives
- Optimal Fetal Positioning/ Facebook
- 3shiresmidwife.co.uk
- Pregnancy Yoga
- Newcastle Hospitals
- Reflexology for Pregnancy
- Spinning Babies
- Birth Angels
- Better Birth Partners
- Maternity Reflexology
- Normal Birth at Barnsley
- Birthing Ball Specialist
- Mumsnet
- Acupuncture for Pregnancy
- Baby world

The list, which by no means covers the extensive array of organisations now promoting OFP, indicates the acceptance of the theory not only by maternity organisations but also by allied health professional.

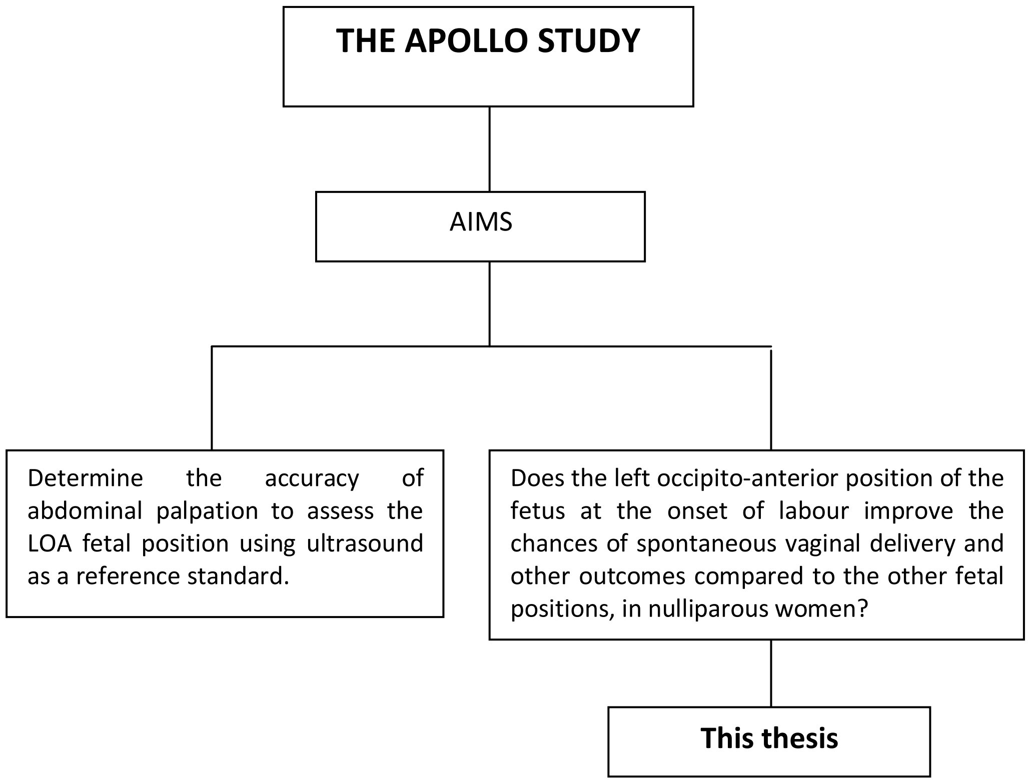
The teaching of the OFP programme is implemented from 34 weeks and commences at the education stage where parents are taught the theory underpinning OFP. A very popular parent education system in England is led by an organisation known as the National Childbirth Trust (NCT). The NCT refers to itself as the UK's leading charity for parents, established since 1956, it has 100,000 volunteers that provide parent education to over 65,000 parents to be. The NCT website has an entire section called 'Best baby position for birth' which includes the leaflet provided by Sutton that promotes OFP (NCT, 2010). The labour and delivery session of the NCT parent education programme is partly dedicated to OFP and thus taught as Sutton recommends to parents at 34 weeks.

In addition Sutton herself has written two books, published articles in well-known midwifery journals, has numerous websites dedicated to OFP and has presented in over a 100 study days and conferences in the UK and across the world. Her theory is also found in midwifery textbooks verifying the increasing acceptance of the OFP theory (Johnson and Taylor, 2010, Yates, 2010, Walsh and Downe, 2010, Davis, 2004, Donna, 2008). It is therefore not imprecise to speculate that due to the diverse group of professionals facilitating Sutton's theories there is acceptance of OFP as a way forward in promoting SVD. However, in an age where all practice should be evidence based, it is critical that the links between fetal position and birth outcomes are established before the practice of promoting a particular fetal position as optimal becomes routine. In order to explore the association of fetal position further the APOLLO Study (Analysis of fetal Position at the Onset of Labour and Labour Outcomes) was designed and conducted at the Birmingham Women's NHS Foundation Trust (BWHCT).

1.8. The Apollo Study

The Apollo study was designed to examine the association of fetal position, specifically the LOA position with labour and delivery outcomes. The study as a whole also explored whether position could be accurately detected by abdominal examination alone, and addressed two interlinked research questions that were essential if the subject area was to be addressed adequately. The determination of a position as optimum would be to little avail if the routine method used to determine fetal position was unproven as accurate. The Apollo study was therefore designed with two separate aims that were addressed by a single study (Fig 1.6). This thesis examines the association of fetal position, specifically the LOA position with birth outcomes.

Figure 1.6. The Apollo Study Objectives.



1.9. Summary

Contemporary midwifery and obstetric practice subscribes to the belief that fetal position at the onset and throughout labour exerts considerable influence on the actual process of labour and its outcomes for both the mother and the fetus. Despite the obvious importance of fetal position there is surprisingly an absence of data within the body of midwifery and obstetric knowledge, specifically in association with mechanism of labour.

The disparity surrounding fetal position is further exacerbated when the CS rate is investigated. Intriguingly the 2001 National Sentinel Caesarean Section Audit report concluded that labour dystocia, or more specifically failure to progress, was the second most commonly cited indication for caesarean delivery (Thomas and Paranjoty, 2001). As failure to progress is not in itself a descriptive diagnosis but rather a symptom, it raises some questions as to the actual diagnosis, it is however probable that fetal position maybe an influencing factor. Fetal position is integral to labour mechanism and is an area that not only requires further attention but also further research.

The importance of fetal position in the mechanistic aspect of the birth process is becoming further recognised and discussed particularly in relation to the right or left side positioning. Commonly the theory of Sutton (2001) that encourage an LOA position to potentially overcome the morbidity associated with mal-position is being applied (Faber, 1998). Since Sutton's work and much of what has been discussed cannot be supported by research evidence, further study supported by a systematic review were undertaken to determine if fetal position at the onset of labour influenced mode of delivery.

CHAPTER TWO

SYSTEMATIC REVIEW ON THE EFFECT OF FETAL POSITION AT THE ONSET OF LABOUR AND ITS INFLUENCE ON MODE OF DELIVERY

2.1. Introduction

The importance of fetal position and its influence on the process of labour and delivery especially the active stages is evident, what remains unclear is the influence of fetal position as that defined at the *onset of labour* and the subsequent influence on the process of labour and delivery. Faber (1998) describes such aptly, suggesting that issues associated with fetal position at labour onset are difficult to establish since no data exists on the subject area. Furthermore the additional controversy as to whether fetal mal-position is the result of mal-rotation from an initial anterior position or whether it is the persistence of a posterior position has meant that understanding fetal position at labour onset has become paramount. Particularly since labour dystocia, the second most common indication for caesarean delivery is thought to in fact be related to fetal mal-position (Goer, 1994).

Simpkin (2010) describes the management of fetal mal-position as complex, risk-laden and expensive, urging the importance of further research into the area, this systematic literature review will aim to address the following question.

2.2. The Review Question

In pregnant women, with a singleton fetus at term gestation, does fetal position at the onset of labour influence mode of delivery?

2.3. Inclusion Criteria

- Population: Term, singleton pregnancies, in early labour/point of labour onset with a cephalic presenting fetus.
- Intervention/exposure: Fetal position of occiput and/or spine confirmed by ultrasound.
- Outcome: Mode of delivery.

2.4. Search Strategy

Studies were reviewed that recruited pregnant women with a singleton cephalic fetus and that were scanned at the onset of labour to determine fetal position and where position was subsequently analysed against mode of delivery. The review was performed systematically of the published literature with no restrictions on year of publication, type of study design and no language restriction was placed.

Search identification included both manual and electronic search strategies. Electronic searches involved the electronic databases and predetermined search terms (Mesh headings). The initial selection criteria was broad to ensure that as many studies as possible were assessed as to their relevance, this assessment was based on the abstract and titles presented in the electronic catalogue. Articles that were clearly unsuitable to the review were excluded at this stage. The remaining articles were ordered and read before a decision to include or exclude was made.

Manual searches were conducted, journals that appear relevant were hand searched and follow-up searches were conducted on citations found in other studies that may be relevant.

2.5. Expert Contact

As Jean Sutton is the expert within the field of interest she was contacted in order to obtain any additional information. Sutton was also asked to provide information on ongoing research that she may be aware of or participating in. All references provided by Sutton were retrieved.

2.6. Electronic Search Strategy

A review was undertaken of the bibliographic databases using the search strategy outlined, this included inputting the relevant search terms for the population, exposure and the outcome. The search included review of the following databases:

- MEDLINE
- EMBASE
- CINAHL
- MIDIRS
- CENTRAL

As the databases were searched, an individual list was maintained detailing the names of the databases searched, the keywords used and the results. Titles and abstracts of studies to be considered for retrieval were printed along with details of where the reference was located. The printed abstracts were then reviewed by the lead researcher and co-researcher independently with consideration of the inclusion criteria and filed once an inclusion/exclusion decision was made by both. Once the inclusion/exclusion decision was made, the two researchers discussed the decision they made and determine agreement.

2.7. Study Selection/Quality Assessment

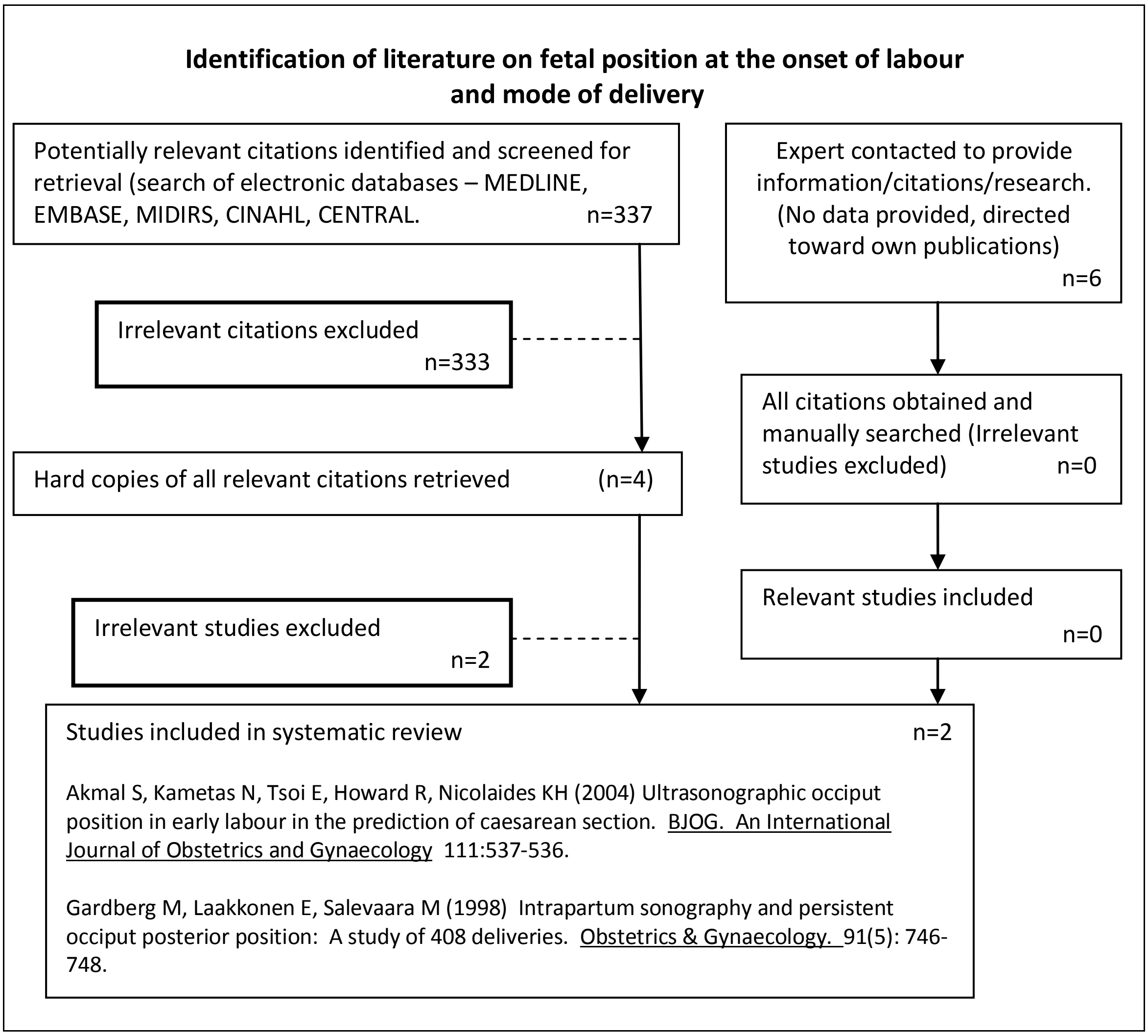
The selection process was undertaken as a group, alongside a senior university lecturer and two research colleagues. All studies that were deemed to be suitable were reviewed by the entire group independently. The senior lecturer of the group provided the quality assessment tool that was used by the group to critically appraise each study. The quality assessment tool used was the Newcastle-Ottawa scale (NOS).

The Newcastle-Ottawa scale is used to assess non-randomised studies including case-control, cohort and observational studies. The scale uses a star allocation method to determine quality. The scale allocates a maximum of nine stars for quality of selection, comparability, exposure and outcome.

Following independent review of each study, joint discussion would take place and where reviewer’s conclusions over the validity differed; a further joint review would take place in order to achieve agreement.

The results of the search are outlined in Figure 2.1 (see appendix 1 for performed searches).

Figure 2.1. Process of systematic review and results



The two studies found from the systematic review are presented in Table 2.1 highlighting the key factors of each study.

Table 2.1. Synopsis of studies located through systematic review

Author	Study design	Population/ Sample size	Stage Fetal position defined	Technique used	Outcome	NOS Score
Akmal et al. 2004	Prospective study	Singleton pregnancies, cephalic presentation. 601 women.	Cervical dilation 3-5 cm, defined as early labour	Ultrasound by trained sonographers	Prediction of caesarean section	6/9
Gardberg et al. 2004	Prospective Study	Singleton pregnancies ≥ 37 weeks. Vertex presentation. 408 women.	Onset of labour	Ultrasound	Labour duration, mode of delivery, Apgar scores, Fetal rotation.	7/9

2.8. Results

Akmal et al. (2004b) undertook a prospective study with the aim of using ultrasound imagery to determine fetal position in early labour in order to predict the likelihood of CS. The study involved 601 women recruited during February 2001 to April 2002 who were between 37-42 weeks pregnant with a singleton cephalic pregnancy. Data on position and outcome were obtained for all the women included in the study. Akmal et al. (2004b) used ultrasound to determine fetal occiput position that was defined as either anterior, posterior or lateral with no further categorisation. Fetal position was determined in early labour; this period was defined as cervical dilatation ranging from 3-5 cm. The specific aim of the study was to determine if the occiput posterior position was an independent factor in the prediction of CS delivery.

Akmal et al. (2004b) found that the posterior fetal position occurred in 35% of cases, with the transverse position occurring in 38% of cases, and the anterior position in 27%. The distribution of the posterior position was almost equally distributed amongst nulliparous and multiparous women (35% and 34%). Despite the almost equal distribution of posterior presentations, the rate of caesarean delivery varied significantly between the multiparous and nulliparous groups, a further increase was observed when women who underwent induction of labour were analysed. The results of the analysis are shown in table 2.2 with the estimates of CS delivery according to fetal position, parity and mode of labour onset with 95% confidence intervals.

Table 2.2. Fetal position against mode of delivery in multiparous and nulliparous women

	Spontaneous Labour		**Induced Labour**	
Occiput	**Primiparous Estimates (95% CI)**	**Multiparous Estimates (95% CI)**	**Primiparous Estimates (95% CI)**	**Multiparous Estimates (95% CI)**
Anterior	*0.15 (0.05,0.24)*	0.02 (0.00*,0.07)	0.19 (0.05,0.32)	0.03 (0.00*,0.09)
Lateral	0.08 (0.02,0.14)	0.07 (0.01,0.14)	0.40 (0.26,0.54)	0.05 (0.00*,0.12)
Posterior	0.22 (0.13,0.31)	0.07 (0.00,0.14)	0.31 (0.15,0.47)	0.20 (0.07,0.32)

*= negative value rounded to zero

Akmal et al. (2004b) concluded that parity, mode of labour onset and posterior fetal position increased the likelihood of caesarean delivery ($p \leq 0.001$, p=0.001 & p=0.005 respectively). There was no association between the lateral or anterior position and an increase in the likelihood of caesarean delivery.

It was also found through multiple regression analysis that the following were significant factors that were independently predictive of CS delivery:

- Maternal age
- Afro-Caribbean origin
- Height
- Parity
- Labour onset
- Gestation
- Head descent
- Male gender – Fetal

The quality assessment of Akmal et al.'s (2004b) study using the NOS achieved 6/9, with stars not allocated for representativeness in the selection category as no method of selection was discussed; instead women admitted to a single department were selected to take part in the study. A lack of control (i.e blinding) in the comparability category also meant a star was not allocated and finally a lack of independent assessment of ultrasound findings in the outcome category meant a further star was not allocated. Overall the study was conducted well and answered the research question posed.

The second study identified through the systematic review was that conducted by Gardberg et al. (1998). Gardberg et al. (1998) undertook a prospective study of 408 women with singleton, cephalic fetuses at term gestation. Each woman underwent an ultrasound on admission to hospital for induction of labour or for spontaneous onset of labour. Fetal position for the purpose of the study was categorised as either anterior or posterior. A posterior position was categorised as the observation on ultrasound of both orbits facing the symphysis pubis and with the spine seen posteriorly. All other observations on ultrasound were classed as anterior fetal positions. Interestingly no further sub-division of position was noted; instead the transverse position of the fetus was also classed as an anterior fetal position.

Fetal position on admission was compared to position at delivery as recorded by the attending clinician. Duration of the first and second stage of labour, mode of delivery, and Apgar scores were recorded as outcome variables.

Gardberg et al. (1998) found that of the total study population 61 (15%) of fetuses were posterior at the onset of labour, and 21 (5.1%) were posterior at delivery. Of the posterior fetuses that were found to be OP on admission 53 (87.5%) rotated and were in an anterior position at delivery. This supposed that only 8 cases of posterior fetal position persisted throughout labour and delivery.

Gardberg et al. (1998) however, found that a total of 21 fetuses were posterior at delivery, concluding that the additional 13 (62%) were as a result of fetal mal-rotation from an initial anterior fetal position rather than a persistent OP position from labour onset. Gardberg et al. (1998) found that the OP position was not associated with labour induction, epidural use, maternal BMI, duration of first and second stage or mode of delivery.

Gardberg et al.'s (1998) study achieved a NOS score of 7/9 stars using the NOS category. Similarly to Akmal et al.'s (2004b) study a lack of control (i.e blinding) in the comparability category meant a star was not allocated and a lack of independent assessment of ultrasound findings in the outcome category meant a further star was not allocated. Gardberg et al. (1998) achieved full allocation of stars for the selection category.

2.9. Discussion

The question posed by the systematic review was:

In pregnant women, with a singleton fetus at term gestation, does fetal position at the onset of labour influence mode of delivery?

In the outlined studies both the population and the outcome being addressed were included within the studies. What was absent from both studies was the use of the standard definition of labour onset and the inclusion of all fetal positions, suggesting that although population and exposure were addressed, this was not done comprehensively. What was apparent from the systematic review was that there is an absence of knowledge in the area of all fetal positions and related outcomes.

Of the two studies located from the systematic review neither answered the review question in its entirety. Akmal et al.'s (2004) study remains slightly ambiguous, as in the title it stated that position would be defined in early labour. Throughout both the abstract and the study however, Akmal et al. (2004) outlined that it was the early yet 'active' first stage of labour that was the point at which position was determined. This is not however, the common definition for 'early labour'. In the vast majority of cases early labour is defined as the latent or non-active phase of the labour process.

Furthermore, Akmal et al. (2004) defined position into three categories this is despite there being 8 variations in the distribution of fetal position. This limited Akmal et al.'s (2004) study as the entirety of the exposure (fetal position) was not considered, but instead only a sub-section of the overall exposure was explored. This would appear to be the main limitation of the study. Finally the study did not answer the question of the systematic review, the aim of

Akmal et al.'s (2004) study was to identify factors that would predict the likelihood of CS rather than analyse position with mode of delivery.

The study conducted by Gardberg et al. (1998) also had fundamental flaws which were not addressed and therefore the findings must be interpreted cautiously. Fetal position was categorised into OA and OP position only, this is despite the understanding that the majority of fetuses will commence labour in the transverse position. By including the transverse position as an anterior position it may be argued that this was misclassification of the OA position and as a consequence associations that others have reported were not observed.

Furthermore in Gardberg et al.'s (1998) study ultrasound was performed upon admission to the hospital, this criterion alone was used to represent 'position at labour onset'. What is not clear is whether there were any additional criteria that allowed Gardberg et al. (1998) to draw conclusions relating to position at the 'onset of labour'. Women may had arrived in either established labour or early labour, in which case descent and rotation may have already commenced suggesting that position was misdiagnosed. If women were in early labour further follow-up was not reported, suggesting that women who are often sent home in early labour and return days later did not have a repeat scan and consequently there was no way of detecting if the recorded position was the actual position at the onset of labour.

The fundamental flaws in Gardberg et al.'s (1998) study imply that his conclusions are poorly supported by the study he undertook. Despite this, Gardberg et al. (1998) has challenged current understanding by concluding that persistent posterior positions at delivery are a result of mal-rotation from an initial OA position. This is contrary to common belief that the OP is a persistence of an initial posterior fetal position (Neri et al., 1995).

Despite such findings Gardberg et al.'s (1998) study failed to answer the review question, mainly due to the restrictive definition of fetal position. Thus the absolute absence of data on all fetal positions at the onset of labour and influence on mode of delivery would suggest that such factors require clear definition and exploration. This thesis will attempt to address the issue pertaining to accurate identification of all fetal positions at the point of labour onset and the association with birth outcomes.

CHAPTER 3

METHODOLOGY

This chapter will discuss the methodologies available for the various elements of the research. The potential research question will be explored and discussed in relation to the rationale for the most appropriate methods to be used if it is to be answered comprehensively.

Following review of the literature and systematic review it was evident that insufficient knowledge exists within the area of fetal position at labour onset and the associated birth outcomes. The principle aim of the research was to determine all fetal positions at the point of labour onset, specifically the LOA positions, in association with birth outcomes.

3.1. Study Design

The nature of the question posed meant that a quantitative approach was required in order to obtain the necessary data. A quantitative approach allowed measure of the variable of interest in a manner that could then be analysed using statistical methods to determine statistical significance. Qualitative research is primarily exploratory in nature with the aim of generating new theories and ideas and therefore not applicable to answer the research question of this study.

The type of quantitative study design required was observational and the most appropriate and high quality design given the research question was a cohort study. An experimental design was not suitable. There has already been a randomised controlled trial to determine if maternal posturing could manipulate fetal position during the antenatal period on the assumption that fetal position is predicted of birth outcomes (Kariminia et al., 2004). The clear absence of evidence that position is predictive of outcome however questions the rationale for an experimental design at this stage. The background and systematic review supports the approach to determine the relationship, if any, between fetal positioning and birth outcomes before an intervention to test the ability to manipulate fetal positioning. The specific characteristics of a prospective cohort study mean recruitment of a cohort of participants, in this instance pregnant women with a cephalic presenting fetus can be identified, assessed in terms of exposures of interest and followed-up to record the outcome of interest which in this case was birth outcomes.

3.2. Composition of Sample

Maternal parity in research has always posed a concern with regards to controlling for confounding variables since a nulliparous birth has many known different characteristics and in many studies statistical methods are used to control for this. This study however is based on a theory that is applicable to the nulliparous women only. Sutton claims that the distinct shape of the uterus is exclusive to nulliparous women and it is this distinction that dictates rotational descent. She claims that the distinct uterine shape encourages anterior rotation of the LOA fetus and posterior rotation of the ROA fetus (See section 1.5. – OFP theory). She considers that the distinct uterine shape is not maintained in subsequent pregnancies and thus the theory of OFP is not applicable to multiparous women (2001). It is therefore necessary that the study participants be nulliparous women.

Additionally the increasing rates of CS are substantially influenced by the rates of repeat CS from an initial operative delivery (Thomas and Paranjoty, 2001). The ability to encourage SVD amongst nulliparous women could curtail the concerns associated with repeat operative delivery and therefore aim to reduce the CS rate.

The remaining study inclusion criteria were in the main also dictated by Sutton's theory which applied to women who were term, with no known fetal abnormalities, be alive and singleton. Sutton's theory is underpinned by the belief that uterine anatomy will influence directional descent of the fetus consequently participants must therefore be grown to full term. Finally the requirement of a cephalic presenting fetus was compulsory if the area of fetal positioning was to be explored.

3.3. Method of Measure

The research involves accurate identification of fetal position, normal clinical practice being to determine fetal position at the onset of labour/induction of labour by abdominal palpation only. Abdominal palpation is described as inexact and subjective with limited evidence supporting its accuracy (Ridley, 2007).

Only one study was found that examined the validity of abdominal examination to determine fetal presentation and position (McFarlin et al., 1985). McFarlin et al. (1985)

conducted a prospective cohort study of 176 participants who had an abdominal palpation to determine fetal position and an abdominal ultrasound scan to compare its findings. McFarlin et al. (1985) did not report the ultrasound findings, or highlight how fetal position was determined on ultrasound. Instead, women who were in antenatal clinic and scheduled for an ultrasound scan were approached to take part in the study. If consent was obtained, abdominal palpation was performed prior to their booked ultrasound. The method by which the sonographers reported, documented or assessed fetal position was not described. Of the 176 women who participated, only 131 were cephalic so fetal position was only determined on a 131 women. McFarlin et al. (1985) claimed that of the 131 participants, correct assessment of fetal position was identified in 60.3% of cases overall, describing the results as ‘disappointing’. The study had many limitations including a poor sampling technique and further still despite the study using ultrasound to confirm fetal position it claimed that some women did not receive an ultrasound scan if the examining clinician was very certain of his/her findings. These limitations mean that the results must be interpreted cautiously but indicate concerns about palpation accuracy.

It was apparent that the use of abdominal palpation to determine fetal position would not be sufficient. The alternative method that has been used and often referred to as the ‘gold standard’ method is ultrasound. Ultrasound imagery has been described as a major tool in medical imaging and specifically the most significant technology introduced to Obstetrics (Doubilet and Benson, 2003, Sherer et al., 1998). A review by Sherer et al. (1998) of ultrasonography compared the importance of ultrasound in obstetrics to blood banking, the discovery of antibiotics and anaesthesiology. Ultrasound is understood to represent the superior method of obtaining internal imagery, which can be used at any point in pregnancy and maybe performed for maternal or fetal reasons (Sherer et al., 1998).

Ultrasound technology uses sound waves produced at a very high frequency to transmit images (Doubilet and Benson 2003). The vibrations of the sound waves produce wavelengths or echoes, which are converted into images on a screen. Hard tissues, such as bone, reflect bigger echoes and are therefore white in the produced image (Dewbury et al., 2001). Soft tissues such as muscles are reproduced as grey images, and fluids, such as amniotic fluid appears black as the sound waves travel through the fluid creating no vibrations.

Ultrasound has been adopted into main stream obstetrics and is used throughout the period of pregnancy, labour and post partum and used routinely to investigate fetal development, growth, abnormality and to perform certain medical interventions (Sherer et al., 1998).

The importance of determining fetal position in labour and the belief that the standard palpation method of identifying position may be inaccurate has led to several ultrasound studies. The first studies reported were as early as 1985 and 1989 that have successfully used ultrasound to determine fetal position in labour (Rayburn et al., 1989, McFarlin et al., 1985). Over the past decade various studies have compared digital vaginal examination with trans-abdominal, trans-perineal and trans-vaginal sonography.

Sherer et al. (2002b) conducted a prospective study to test the null hypothesis that no correlation exists between digital vaginal examination and trans-abdominal supra-pubic ultrasound to determine fetal head position during labour. 102 consecutive patients with normal singleton, cephalic, term fetuses in established labour of 4cms or more were included and the ultrasound scan was performed immediately after digital examination.

Head position was classified as direct OA, direct OP, left or right occiput transverse (LOT, ROT), left or right occiput anterior or posterior (LOA, LOP, ROA, ROP). The results illustrated that even when a 45° allowance of angle discrepancy for fetal position was allowed, an error rate of 53% was encountered (Sherer et al., 2002). Sherer et al. (2002) thus concluded from his study that intrapartum ultrasound increased the accuracy of determining fetal head position during the active first stage of labour.

Sherer et al. (2002a) then repeated the study this time including 112 patients in the second stage of labour. The null hypothesis tested was that no correlation exists between trans-vaginal digital examination compared with trans-abdominal supra-pubic ultrasound to assess fetal position in the second stage of labour. The results revealed an error rate of 39% when a 45° angle of discrepancy was allowed between digital vaginal examinations compared to trans-abdominal ultrasound findings. Sherer et al. (2002) noted that although compared with the first study in the active first stage of labour the error rate was lower in the second stage of labour, it remained 'considerably high', thus concluding that intrapartum sonography increased the accuracy of determining fetal position in active first and second stage of labour (Sherer et al., 2002).

Akmal et al. (2003) performed a similar study looking at digital vaginal examination compared to trans-abdominal ultrasound to determine fetal head position prior to instrumental delivery. 64 women with singleton pregnancies undergoing instrumental delivery were recruited to the study. Both digital vaginal examination and trans-abdominal ultrasound were performed one after the other. The vaginal examination was considered correct if as in Sherer et al's (2002) study fetal position was within 45° of the ultrasound findings. It found that digital examination during instrumental delivery failed to identify the correct fetal head position in 26.6% of cases. As a 45° angle of discrepancy was allowed Akmal et al. (2003) describes the error rate as a 'substantial discrepancy'. The significance of such an error is thought to affect instrument application, being incorrectly applied due to the inaccurate identification of fetal position. The error rate further increased with non anterior positions. The rate of identifying an anterior position using digital vaginal examination was 83% compared to 54% for lateral or posterior positions (Akmal et al., 2003). The study concluded that trans-abdominal ultrasound should be used routinely prior to instrumental delivery to determine fetal head position.

Kreiser at al. (2001) performed a similar study including 44 women to determine fetal occiput position by ultrasound during the second stage of labour. The error rate reported by Kreiser et al. (2001) was 30%, concluding that ultrasound use to determine fetal position was 'significantly superior' compared to traditional methods of determining fetal position.

Chou et al. (2004) investigated fetal position in the second stage of labour of vaginal compared with ultrasound examination to determine fetal occiput position and fetal spine position in the second stage of labour. 88 patients participated and were given both trans-abdominal ultrasound and trans-perineal ultrasound to determine fetal occiput position. The predicted positions by both methods of ultrasound and digital vaginal examination were compared against position following spontaneous restitution or position at caesarean delivery to determine accuracy. As with the previously outlined studies Chou et al. (2004) showed that ultrasound was more accurate than digital vaginal examination, which had an error rate of 28.4%. Chou et al. (2004) did not compare the accuracy of trans-abdominal ultrasound with trans-perineal ultrasound in this study.

Zahalka et al. (2005) went further to study the determination of fetal head position using 3 different examination techniques, comparing digital vaginal examination with trans-abdominal ultrasound and with trans-vaginal ultrasound. Zahalka et al. (2005) aimed to investigate both accuracy and time requirements of all 3 examinations. Sixty women in the second stage of labour were recruited, and digital vaginal examination was followed by both trans-vaginal and trans-abdominal ultrasound. A 60° angle of discrepancy was allowed between each identified fetal position compared to the position recorded following restitution. The 60° angle of discrepancy was greater than that endorsed in the previous studies, of only 45°. The results confirmed previous findings that digital examination remained the least accurate method of determining fetal head position. The error rate ranged from 15% when the degree of error was greater than 90° to 23.3% when the degree of error was between 60-90° (Zahalka et al. 2005). Zahalka et al. (2005) further concluded that no significant difference in accuracy of determining fetal head position was detected between trans-abdominal and trans-vaginal ultrasound examination. Time requirements were however significantly shorter for the trans-vaginal examination compared to digital or trans-abdominal examination.

Over the past decade numerous studies have consistently shown that trans-abdominal ultrasound examination is the gold standard method of determining fetal head and fetal spine position. Further studies have looked into more invasive methods such as trans-vaginal and trans-perineal ultrasound to determine fetal position to increase accuracy.

These have shown that invasive methods may cause more discomfort to patients and do not increase accuracy when determining fetal position against non invasive methods such as trans-abdominal ultrasound.

All the studies reviewed concluded that ultrasound to determine fetal head position should be used routinely in view of the identified error rate with use of routine methods (Akmal et al., 2003, Chou et al., 2004, Zahalka et al., 2005). Peregrine et al. (2007) states that specifically trans-abdominal ultrasound to determine fetal position is easy to perform and highly reproducible. This highlights not only the importance of trans-abdominal ultrasound in reducing error margins but also its ease of use as a routine assessment tool.

3.4. Point of measure

Sutton's theory was unique since it not only claimed that a single fetal position was optimum but it also claimed that it was position at a specific point in the labour process that would dictate the entirety of the labour and birth process. The specific period was the point of labour onset, interestingly the period of labour onset in the normal process of labour is the point prior to the commencement of rotational descent. This signifies its importance if, it is confirmed that the process of rotational descent is influenced by the position the fetus adopts at the point of labour onset, a position maybe established as optimum.

The 'onset of labour' signifies an important period and thus must be understood and defined with such measure. The point of labour onset, in view of the argument posed by Sutton is the period prior to the commencement of active labour yet succeeding the latent first stage of labour. As is understood (see section 1.1- Normal Obstetric Labour), the process of labour for the fetus involves rotational descent through the maternal pelvic. By determining position once rotation had ensued (i.e active first stage) would not provide information pertaining to a favoured or otherwise fetal position. This would mainly be due to the inability to determine what stage of the rotational process the fetus was at, if position was to be determined during the active first stage of the labour process. Consequently, Suttons claim was very specific in that fetal position at the point of labour onset must be LOA in order to encourage anterior rotation and prevent mal-rotation.

3.5. Definition of labour onset and period of measure

The point of measure for the purpose of this study was labour onset, with the aim of identifying fetal position immediately preceding the point of active labour. The period immediately prior to the commencement of active labour is referred to as the latent phase, labour onset and early labour interchangeably. Labour stages are diagnosed retrospectively with the commencement of a subsequent stage marking the end of the prior stage. The commencement of active labour which is commonly defined as cervical dilatation greater than 4cm with regular uterine contractions would mark the end of early labour/latent phase and labour onset (Tiran, 2008, NICE, 2007).

The latent phase of labour is therefore the point at which measure is to be undertaken however it is poorly understood and is often claimed to be hard to define (McDonald, 2010). There is limited research evidence into the areas of recognition, definition and management of the latent phase. Evidence exists into prolonged and misdiagnosis of the latent phase that often leads to unnecessary admission, leading to increased levels of intervention including increased rates of operative delivery (Chelmow et al., 1993, Maghoma and Buchmann, 2001). The initial definition of the latent phase of labour and much of labour stages was described by Friedman (1978). Friedman (1978) claimed that a latent phase greater than 20 hours in nulliparous women would be classed as prolonged, suggesting that a latent phase up to 20 would be normal. Since then however, many have argued that the length of the latent phase is 8-12 hours with the majority of textbooks reporting 8 hours (Chelmow et al., 1993, Maghoma and Buchmann, 2001, McDonald, 2010, McCormick, 2009, Ladwig et al., 1998, Coad and Dunstall, 2005). There is overall a clear lack of consensus on how long a latent phase of labour should last. The definition of the latent phase appears to have greater consensus, described as commencing when women start to experience painful contractions associated with minimal cervical changes, this definition is also supported by the National Institute of Clinical Excellence (NICE) (McCormick, 2009, NICE, 2007, McDonald, 2010). NICE was established to set high-quality standards derived from the best available evidence. NICE intrapartum guidelines provide a clear and concise definition of latent/early labour up to the point of active labour onset, therefore defining clearly the period during which position is to be identified for the purpose of the research, the definition being:

A period of time, not necessarily continuous, when:

- there are painful contractions, and
- there is some cervical change, including cervical effacement and dilatation up to 4cm.

Established active first stage of labour is when:

- there are regular painful contractions, and
- progressive cervical dilatation from 4cm. (NICE, 2007)

For the purpose of this study the above definition clearly defines the period during which position is to be defined. Bohra et al. (2003) claimed that 81% of nulliparous women were admitted to hospital with a cervical dilation of less than 2cm. This suggests that a large majority of women are likely to be present during the latent phase of labour and therefore for the purpose of the study position can be measured at the specified point.

3.6. Follow-up

Labour and delivery is regarded as a 'process' that is assessed for progress or otherwise over a period of time. Since the point of measure or the latent phase is identified as 'a period of time, not necessarily continuous' it is appropriate to assume follow-up would be necessary. As previously discussed a lack of consensus on how long a latent phase is, remains, however the latent phase requires definition for the purpose of the study in order that a period of repeat measure could be established. The majority of clinical textbooks suggest that the normal length of the latent phase is 8-12 hours (Chelmow et al., 1993, Maghoma and Buchmann, 2001, McDonald, 2010). In view of this it would appear appropriate that fetal position is reassessed and determined if active labour is not established within the defined period of the latent phase of 12 hours. To repeat the measure 8 hourly would require 3 ultrasounds within a 24 hour period. To repeat the scan 3 times was considered to be too much for women who were in pain, potentially sleep-deprived and suffering with increased exhaustion. Since there is no conclusive argument differentiating between 8 or 12 hours, for the purpose of the study it was considered appropriate to use a 12 hour rule of repeat measure.

If the study participant did not enter established labour within 12 hours of the ultrasound scan, a repeat scan was required and the previous scan would become invalid. All study participants who were being induced or in early labour were therefore followed up every 12 hours, and once they were in established labour subsequent follow-up was not required.

The 12 hour rule ensured that position was determined within the period of early labour and close to the commencement of active labour. Without such a rule women who may not have entered labour for several days would not be followed up and therefore it could not be determined with certainty that position was recorded at labour onset.

3.7. Pilot Study

Following determination of the study methodology it was deemed appropriate that a pilot study be undertaken. The pilot study was used to assess feasibility of study implementation, specifically recruitment, up-take of ultrasound during labour, scan technique, 12 hour follow-up rule and documentation.

Three full-time midwives, who covered a 24 hour shift rota, were trained to scan for the pilot study, and covered triage (delivery admissions), labour ward and the birth centre. Two scan machines were available on the delivery suite for use by both the birth centre and triage. Documentation and recruitment was arranged and commenced at the same time throughout the community and hospital settings. During the pilot study, 932 women consented to take part of which 406 were recruited and scanned. Of the 406 women, 280 scans were obtained that contained all the necessary data.

Initial consent to take part in the study using the documentation proved successful, with a large number of participants consenting each month. The manpower however, associated with producing the consent packs on a large scale and distributing them each month was time consuming and took a lot of the research midwives time which could have been spent scanning. As a result it was decided that from the limited study funds available the researchers would pay an individual to assemble and distribute the consent packs.

No participant in the pilot study refused ultrasound or asked the scanning midwife to discontinue at any point. Since the ultrasound took place during labour there were some concerns as to whether women would find it acceptable in view of the possible discomfort caused by uterine activity. Instead, the scanning midwives reported women requesting the ultrasound on admission to the hospital.

The scanning technique used by the midwives was considered to be successful, as in 14 cases was the fetal head too low to measure, highlighting that this was not a major concern for the study. The midwives reported ease of use of the portable scanning machine, clear images and the available facility of darkening the delivery rooms meant that the environment for scanning was adequate.

The principal problem identified was a lack of scanning midwives. The hospital based midwives reported bleeping the scanning midwives but not receiving a response. Three midwives were not sufficient to cover the demand of scans required. This was the main reason why the large number of women recruited were not then scanned and included in the study, which was too low an inclusion rate from those consented.

Furthermore women who did not enter established labour within 12 hours and required subsequent scans were also missed; 75% of women requiring follow-up scans after 12 hours did not receive a scan. This was mainly due to the shift pattern covered by each midwife. The scanning midwives felt responsible for the scans required on their department, none of the midwives took responsibility for the remaining departments whilst on duty. The midwives did however have clinical responsibilities and could not leave their departments so 12 hour follow-up scans were often missed. Additionally the antenatal ward which did not have an allocated scanning midwife was regularly missed, since women would be admitted to the antenatal ward for induction and in the early stages of labour a sizeable group of women were missed.

The problem highlighted by the pilot study clearly indicated a need for more scanning midwives including cover of the antenatal ward. This led to the application for a research midwife to the Research and Development department at the BWHCT. The department awarded funds to allow a research midwife to be appointed for 3 days a week. The research midwife (the author) was based on the antenatal ward, and reduced her clinical hours to ensure she was available 6 days a week to cover the demands of the study. In addition, 3 further midwives were trained to offer additional scanning services. This meant 6 midwives in total including the research midwife were available for the implementation of the study.

Documentation in relation to data collection was deemed adequate. The pilot study demonstrated that implementation of the study using the outlined methodology was adequate. The additional allocation of scanning midwives and the appointment of the research midwife meant that concerns relating to a lack of available staff to perform the scans were overcome for the main study in order that the women recruited antenatally and then lost to follow-up would be reduced.

In view of the methodology discussed, the methods of the research have now been identified for implementation.

CHAPTER 4

METHODS

4.1. Aim of the Study

The aim of this study was to explore the association between fetal position at the onset of labour and birth outcomes for the mother and the neonate. The specific research question was:

Does the Left Occipito-Anterior (LOA) position of the fetus at the onset of labour improve the chances of Spontaneous Vaginal Delivery (SVD) and other outcomes compared to the other fetal positions, in nulliparous women?

4.1.1 Objectives

The main objectives of the study were:

- To ascertain the proportion of all fetal occiput and spine positions at the onset of labour using the 'gold standard' method of ultrasound amongst nulliparous women.
- To determine the relationship between fetal occiput position at the onset of labour and birth outcomes(s) amongst nulliparous women.
- To ascertain if the LOA fetal occiput position at the onset of labour is associated with improved outcome(s) amongst nulliparous women.

- To determine the relationship between fetal spine position at the onset of labour and mode of delivery amongst nulliparous women.

4.2. Study Design

The study design was a prospective cohort study that was set up to fulfil the above aim and objectives. Women were recruited to the study and given an ultrasound scan to determine fetal position at the onset of labour then followed up until birth to determine outcomes.

4.3. Ethics

The study obtained ethical approval from the South Birmingham Research Ethics Committee. The ethics committee suggested the incorporation of non-English speaking women who were initially deemed not eligible. It was thought that since link workers were available to translate during both clinic appointments and during hospital admissions that this group could be included in the study. The recommended amendment was made and approval was obtained. The study was also approved locally by BWHCT Research & Development committee.

4.4. Setting

The study was conducted at BWHCT, one of the largest women's hospitals in England. The trust has a midwife-led birth centre and a consultant-led delivery suite and the study included women who were admitted to both units. Recruitment took place over an 18 month period that commenced in April 2007 until September 2008.

4.5. Participants and Inclusion Criteria

All nulliparous women who were booked at the BWH and met the specified inclusion criteria during the study period were invited to take part. The inclusion criteria are listed below:

- Nulliparous
- Live, singleton fetus
- No known fetal abnormalities
- ≥ 37 gestational weeks
- Cephalic presentation
- Labour spontaneous or induced
- In early labour (cervical dilatation ≤4 cm)

4.6. Recruitment

Women were invited to take part in the study from 28 gestational weeks. All women booked at the hospital were routinely given an appointment to attend a blood test appointment at 28 weeks; this appointment was usually given for a specific clinic (referred to as the community clinic). The community clinics are co-ordinated by the community midwives who were the primary recruiters to the study. Since all women were required to attend community clinic it was thought that this would be an ideal primary venue from which to recruit.

It was anticipated that some women may fail to be recruited from this setting for various reasons, such as staffing pressures or shortages that may prevent the midwife from spending the extra time required to obtain consent to participate in the study. In view of this, it was thought necessary that alongside this recruitment route, link workers, the research midwives and hospital based midwives would also be involved in the recruitment process. Recruitment therefore also took place at parent education classes that were provided at BWHCT for all nulliparous women. Nulliparous women are invited to attend the classes from 34-36 gestational weeks. The research midwives would attend the antenatal classes on a regular basis and recruited women to the study.

Prior to the commencement of the study the research midwives visited each community team and each hospital setting. A presentation of the study was given followed by an extensive description of the recruitment process. An information leaflet devised for health professionals was also distributed (Appendix 2). The information was then re-iterated at a launch presentation, and information clinics were open for 1 week for midwives and women to attend and ask questions.

Consent packs were devised and distributed to all community teams, hospital settings and given to the antenatal teachers. The consent packs included consent forms, information leaflets for women and recruitment stickers to apply to the maternity hand held notes. The packs were available on every department and refilled every month (Appendix 3).

The recruitment process involved:

1. Verbally explaining the research study to the participant and what it involved.
2. Providing prospective participants with an information leaflet.
3. Allowing participants the opportunity to ask questions.
4. If participants agreed to take part in the study, a triplicate consent form was signed. The first copy was given to the study participant, the second was filed in the hospital maternity notes and the third was returned to the researchers.
5. A sticker confirming consent to participate in the study was applied to the hand held maternity notes, so that upon arrival to the hospital the researcher could be informed.

Once women had agreed to participate in the study, they were aware that they may become ineligible later on during their pregnancy if at any stage:

- A fetal abnormality was diagnosed.
- A non-cephalic fetal presentation was diagnosed.
- Labour commenced prior to 37 gestational weeks.
- An elective caesarean section was required.
- Admitted to hospital in established labour (cervical dilatation >4 cm).

Since such information was not known at the initial recruitment stage, numerous women were likely to become ineligible for the study later on. The recruitment process ensured that women were recruited to the study in an ethical manner providing consent voluntarily after assimilating the relevant information. It was also outlined clearly that women could withdraw their consent to participate in the study at any point.

4.7. Determining Fetal Occiput and Fetal Spine Position by Trans-Abdominal Supra-Pubic Ultrasound

Once consent was obtained, upon admission to the hospital eligibility and consent was confirmed and fetal position was then determined. Fetal position was determined by trans-abdominal ultrasound that used intracranial structures identified in the fetal brain as markers to identify fetal position. All studies using ultrasound to determine position have used the same markers. The anatomy of the fetal brain allowed clear identification of the fetal head position in relation to the female pelvis.

For the purpose of this study the following trans-abdominal supra-pubic ultrasound technique was used.

- With the mother in the supine position the ultrasound transducer was placed in the transverse plane on the supra-pubic area of the maternal pelvis.
- The examination was directed to the fetal cranial vault, in the axial plane.
- Fetal position was then determined using the cranial contour, cranial midline, fetal orbits, nasal bridge and the paired thalami (Appendix 4). It was clear from other studies that not all intracranial landmarks are visualised every time, yet each scan would have position defining structures recorded. In cases where structures were difficult to identify 'slight lateral angulation' and 'lateral rocking' of the transducer was applied which assisted in the identification of the structures.
- The transducer was then placed on the maternal abdomen in a longitudinal manner to obtain a sagittal plane view of the fetal spine. The sagittal plane view of the fetal spine is only obtained when the transducer is directly above the fetal spine therefore allowing detection of its position in relation to the maternal abdomen.

Although several structures were used to determine fetal head position, most authors agreed that the most consistently depicted intra-cranial fetal head position defining structure was the paired thalami (Souka et al., 2003, Sherer and Abulafia, 2003, Chou et al., 2004).

4.8. Fetal Position - Occiput

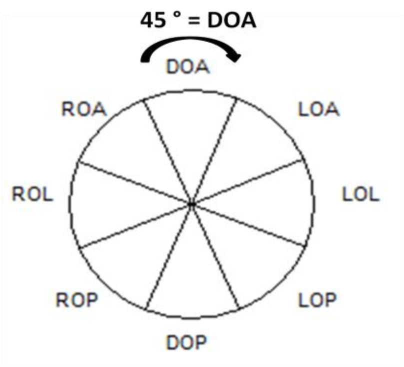
Fetal occiput position was categorised into the following 8 groups:

Direct Occipito-Anterior	- DOA
Left Occipito-Anterior	- LOA
Right Occipito-Anterior	- ROA
Left Occipito-Lateral	- LOL
Direct Occipito-Posterior	- DOP
Left Occipito-Posterior	- LOP
Right Occipito-Posterior	- ROP
Right Occipito-Lateral	- ROL

Although almost every midwifery and obstetric textbook highlights the above positions, what is not clear is exactly where one position ends and where the next position commences within the 360° pelvic cavity. What is generally highlighted is the mid-point of each fetal occiput position in relation to the 360° female pelvis. With this information, figure 3.1 illustrates the complete identification of each fetal position for the purpose of this study.

As there are 8 fetal positions and the mid-point for each position is known within the 360° pelvic cavity an equal 45° proportion was allocated to each fetal position. The distribution of degrees was 22.5° to either side of the mid-point of each fetal position (Fig. 4.1). The above method is similar to that utilised by Sherer et al. (2002), Akmal et al. (2003), Kreiser et al. (2001), Gardberg et al. (1998) and Zahalka et al. (2005). Although the authors spoke about fetal position in relation to degrees within the maternal pelvis they did not outline exactly how it was allocated. This may simply be due to the authors presuming that position would be distributed in such a manner.

Figure 4.1. Classification of fetal occiput position within the 360° pelvic cavity



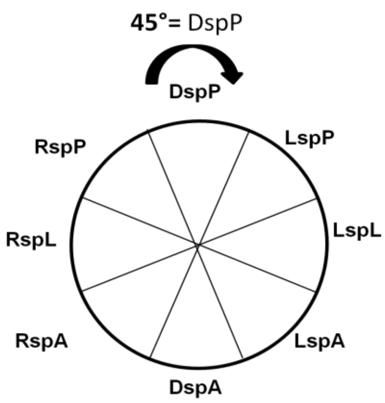
4.9. Fetal Position - Spine

The fetal spine position was determined using a similar technique. The position of the fetal spine is rarely recorded as a separate feature from the occiput and does not have any outlined individual position categories. Furthermore, the routine procedure of abdominal palpation as outlined in textbooks only refers to the lie of the spine and not position (Viccars, 2009). Despite this there remains an argument as to whether the fetal spine is used instead of the fetal occiput to determine fetal position and in view of this, the spine position was, for the purpose of the study categorised and recorded as follows:

Direct spine Anterior	- DspA
Left spine Anterior	- LspA
Left spine Lateral	- LspL
Left spine Posterior	- LspP
Direct spine Posterior	- DspP
Right spine Posterior	- RspP
Right spine Lateral	- RspL
Right spine Anterior	- RspA

The spine position was allocated in the same manner in which the occiput position was distributed; however this was done in relation to the maternal abdomen and not the pelvis. Figure 4.2 below outlines the spine allocation.

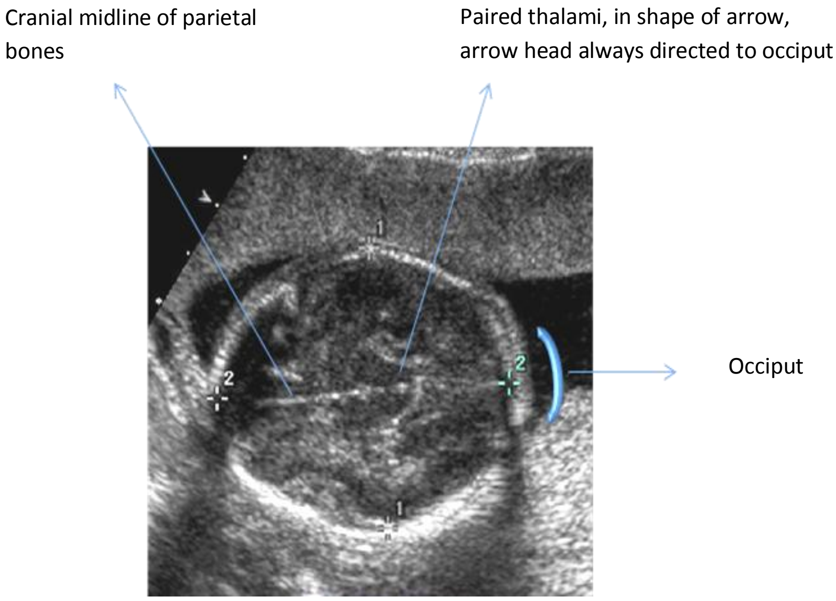
Figure 4.2. Classification of fetal spine position within the 360° abdominal cavity



4.10. Description of Ultrasound Technique Used to Determine Fetal Position.

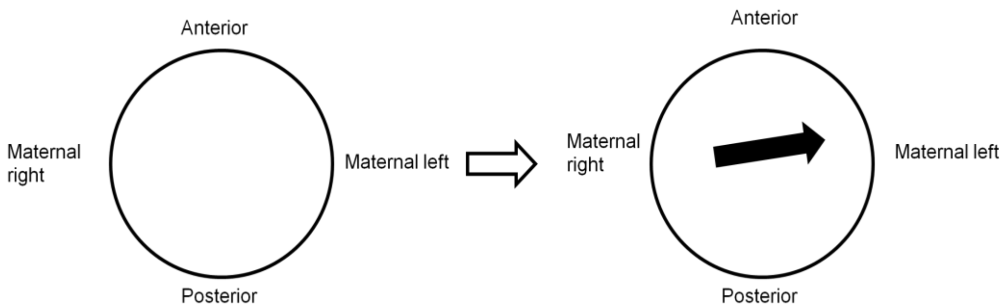
Fetal occiput and spine position was determined using a trans-abdominal ultrasound scan at the onset of labour. The ultrasound scan was performed by trained midwives. The ultrasound training took place with 4 senior sonographers who first presented a session on the use of the scanning machine. This was followed by discussion and agreement that key intra-cranial structures would to be used to identify fetal position. The structures to be used to determine fetal position included the cranial contours, cranial midline, orbits, and nasal bridge (Appendix 4). Since the paired thalami were outlined as the most consistent intra-cranial fetal head position-defining structure, this was the primary structure used to define position. The paired thalami sit posteriorly along the midline cranial contour of the parietal bones. Figure 4.3 highlights the identification of the thalamus gland (paired thalami).

Figure 4.3. Occiput identification (Doubilet & Benson 2003)



The thalamus gland can be seen clearly as an arrow, the arrow head points to the occiput, the identification of the arrow head outlines the position of the occiput. Using the scan technique explained in section 4.10 the scanning midwife would identify the midline and the thalamus gland to ascertain fetal position. A printed picture similar to the one in Fig. 4.3 was required identifying the visualised position defining structure. The midwife then replicated the structure in a diagram found on the ultrasound examination form (Appendix 5). The illustration below shows a blank diagram and a completed diagram, showing how the thalamus gland or the position defining structure was replicated by the midwife, allowing identification of the fetal position. The external structures of the maternal pelvis remain constant; therefore the rotating thalamus gland was replicated within the diagram below.

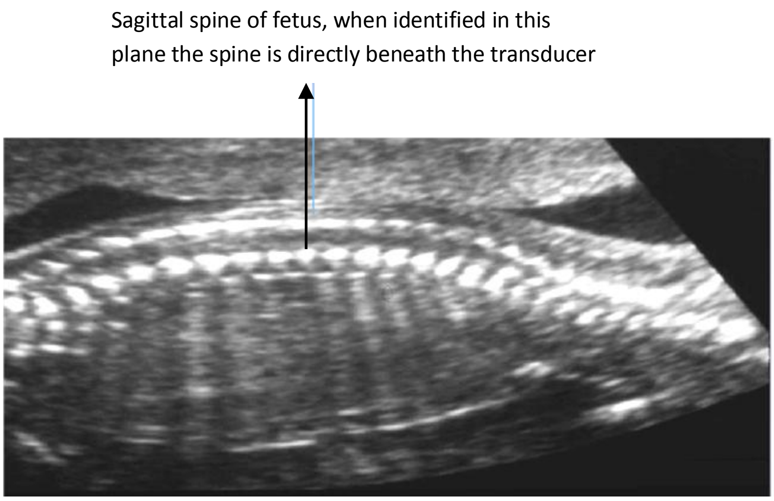
Figure 4.4. Recording fetal occiput position



If the thalamus gland was not identified but instead the orbits and nasal bridge were, then they were replicated as they were visualised. If however, the cranial contour was the only identifying structure the scanning midwife took a picture to confirm this, and ticked the appropriate box highlighting which position it was. The cranial contour would only determine either of the direct positions (DOA or DOP).

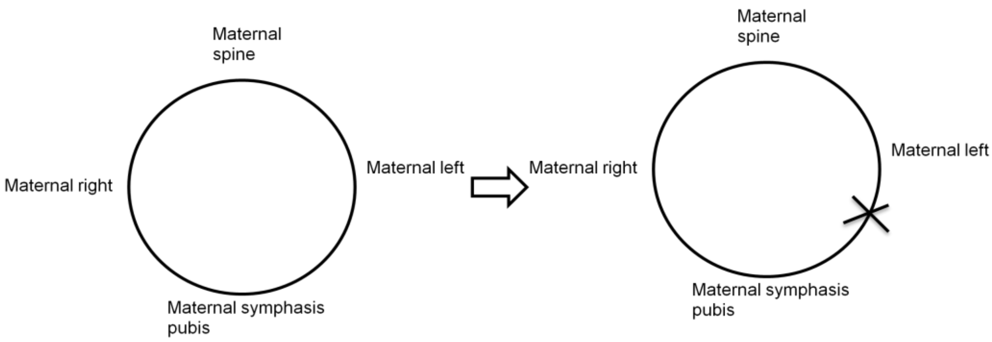
Once the occiput position was defined, the midwife was required to identify the spine position. The identification of the sagittal spine as shown in figure 4.5 identifies its location in relation to the maternal abdomen.

Figure 4.5. Spine identification (Doubilet & Benson 2003)



When the spine is seen in the above plane, the location of the spine is directly beneath the scan transducer. The location of the transducer on the maternal abdomen was used to record its actual location. The spine position was then marked as an X in relation to the mother's abdomen on the ultrasound examination form (Appendix 5), as seen in figure 4.6.

Figure 4.6. Recording fetal spine position



The ultrasound examination provided an accurate fetal occiput and spine position at the onset of labour for the purpose of this research study.

4.11. Study Implementation

Upon admission to BWHCT, all study participants were highlighted by the recruitment sticker attached to the front of their maternity notes that were collected by the attending midwife. The sticker contained the bleep number of the research midwife who was contacted and informed of the admission.

Women who were admitted in labour had their routine observations completed by the attending midwife. Once the midwife diagnosed the stage of labour, the research midwife was informed. If the attending midwife decided that the study participant was not in labour (no cervical change) the research midwife would not perform the ultrasound scan. Instead the women would be discharged and re-admission would be awaited and the process on subsequent admissions repeated.

If the study participant was found to be in the active stage of labour, that is, cervical dilation greater than 4 cm the participant would become ineligible for the study. If the study participant was found to be in the early stages of labour the research midwife would perform the ultrasound to determine fetal occiput and spine position.

Women who attended the hospital to be induced would be admitted to the antenatal ward if induction by prostin tablet was required. If women were required to be induced by intravenous infusion, admission would take place directly on to the labour ward. Once women were admitted to the antenatal ward for prostin induction of labour, the attending midwife would perform the necessary observations. Following this the research midwife would attend and perform the ultrasound scan prior to prostin insertion. If women were admitted for intravenous infusion for labour induction the above outlined prostin procedure would be followed but ultrasound would take place prior or immediately after commencement of the intravenous infusion, and before established first stage of labour.

4.12. Obtaining a 'Valid' Scan

Once it was confirmed that the study participant was in early labour, the ultrasound scan could be performed by the research midwife. The attending midwife and the study participant were blinded to the findings of the ultrasound scan. This ensured that the care and management of the study participant was not altered or influenced in any way by the ultrasound findings. In order to obtain a 'valid' scan, key observations were mandatory as follows:

1. The fetal heart was observed and was beating at a normal rate (confirmed and documented on form B – Appendix 5).
2. The scanning probe was checked for alignment (confirmed and documented on form B - Appendix 5).
3. Position defining structures were observed within the cranial vault and documented as seen.
4. The fetal spine was observed and documented as seen.

If a heart rate abnormality was detected at any point, the scan was abandoned and immediate medical attention sought. If the probe check was not confirmed and documented the ultrasound scan was not used. The incorrect handling of the probe would alter the direction of the image on the screen therefore fetal position would be misdiagnosed.

In certain cases the descent of the fetal head into the maternal pelvis meant that the contents of the cranial vault could not be visualised. Therefore no position defining structures could be identified. In this instance the scan would be invalid as the test result would be technically unobtainable.

Although it was not expected, in situations where the research midwife could not define position of the fetal spine this would also be classed as an 'invalid' scan where the test result was technically unobtainable. When the ultrasound scan was completed the data collection form was immediately sealed in an envelope and placed in the research file.

A 'valid' scan was therefore that which was performed at the onset of labour, with the observation of both position defining structures present (fetal spine/fetal occiput) and where the mother was in established first stage of labour within 12 hours of the ultrasound findings being recorded, only then was a scan classified as a 'valid' scan.

Figure 4.7 illustrates the study process following admission to the hospital of a study participant.

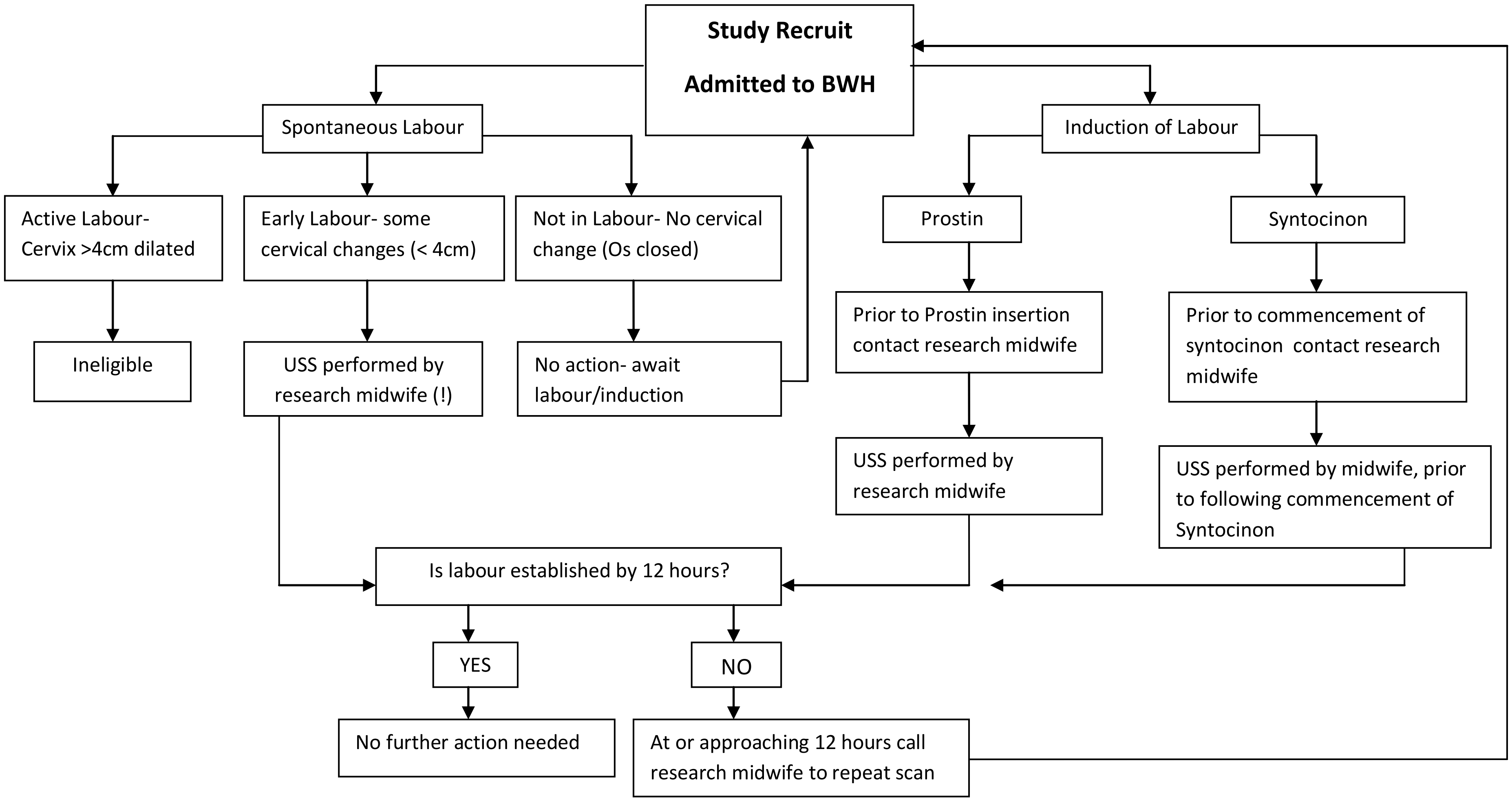


Figure 4.7. Study flow following admission

(!) If on USS fetus is found to be anything other than a cephalic presentation, women will become ineligible for the study

4.13. Outcome Measures

The outcome measures that were included were determined by two factors: the customary outcome measures commonly used when investigating factors relating to birth, and those, that Jean Sutton claimed were improved with the LOA fetal position.

The following definitions of the outcome measures are used at the hospital where the study was conducted and therefore are also those that were used for the purpose of this study.

4.13.1. Primary outcome

The primary outcome measure was mode of delivery, categorised into 4 main categories as defined by Tiran (2008):

- Spontaneous Vaginal delivery (SVD) - SVD is the complete expulsion of the fetus, placenta and membranes via the birth canal.
- Ventouse delivery (VD) - VD involves the application of an instrument to the fetal head and use of vacuum or suction to aid delivery of the fetus with maternal expulsive efforts.
- Forceps delivery (FD) - FD involves surgical instruments with two blades applied to the fetal head to aid rotation and/or delivery. These include Kjellands, Neville Barnes and Wrigley's forceps.
- Caesarean Section Delivery (CS) - CS involves an operation whereby the fetus is extracted from the uterus following an incision through the maternal abdomen and uterine tissue.

4.13.2. Secondary outcomes

The secondary outcome measures were:

- Augmentation - Augmentation is the acceleration of labour once it has been diagnosed as not progressing adequately. Inadequate progress is defined by NICE Intrapartum guidelines as cervical dilatation less then 2cm within a four hour period, in such a situation labour would be augmented (NICE, 2007). The method used to augment the labour process is usually performed in order of least severity. Artificial Rupture of Membranes (ARM) or amniotomy would be performed first. Following this, intravenous syntocinon infusion would be commenced which is a synthetic oxytocic drug used to encourage uterine activity. Syntocinon stimulates the uterus with the aim of increasing strength and duration of uterine contractions. If however, the membranes have previously ruptured spontaneously, syntocinon would be the first and only option available to augment labour.

- Labour duration - Labour duration was categorised into the active first stage of labour, the second stage of labour, and duration of membrane rupture. The first stage of labour was defined by the NICE (2004) intrapartum guidelines as the period of regular painful contractions, and where there is progressive cervical dilatation from 4 cm up to 10cm. The second stage of labour is the point at which full cervical dilatation of 10cm is diagnosed until the delivery of the fetus (Tiran, 2008). Duration of membrane rupture is defined as the period commencing rupture of the amniotic sac until the delivery of the fetus (Tiran, 2008).

- Pain relief - Non-pharmacological forms of pain relief include Transcutaneous Electrical Neural Stimulation (TENS), inhalation analgesia (entonox) and immersion in water. Pharmacological forms of pain relief include systemic analgesia such as Pethidine, which is a sedative and an anti-spasmodic drug. Epidural analgesia involves an injection of local anaesthetic into the epidural space in the lumbar region of the spinal cord (Tiran 2008). Other forms of regional and local analgesia are usually administered prior to intervention or operative delivery in emergency situations. They include spinal and pudendal block and in certain cases general anaesthetic.

  In many cases women use more than one type of pain relief usually progressing from non-pharmacological forms to pharmacological forms of pain relief.

- Fetal condition at birth - The condition of the neonate was assessed at 1 minute and 5 minutes using the Apgar score. The Apgar score is an acronym for: Activity, Pulse, Grimace, Appearance and Respiration and is usually assessed by the midwife or paediatrician at delivery. Each aspect of the Apgar score was assessed with a 0, 1 or 2. A score of 8-10 was considered normal, whilst a score of 4-7 might require some resuscitative measures, and a neonate with an Apgar score of 3 and below would require immediate resuscitation.

4.14. Data Collection

Data were collected at 3 stages for each study participant. Baseline data was routinely recorded on maternal parity, age, ethnic group, height, weight and body mass index at the initial pregnancy booking stage. The data was retrieved for the study following a request to the informatics department.

The assessment of fetal position required an accessible, accurate and reproducible method that the ultrasound technique used provided, further highlighting that a consistent data collection tool was used.

The data collected on fetal position was recorded on an examination sheet (Appendix 5), verified by an independent clerk who then entered all the data into an excel spreadsheet ready to merge with the outcome data.

Following delivery of the study participants, outcome data for the primary and secondary outcome measures which were routinely recorded for all women at the hospital were obtained from the informatics department. The informatics department was given a list of the outcome data that was required for each participant. From the list a program was created and once registration numbers for the study participants were obtained the program was processed and an excel spreadsheet produced. The spreadsheet incorporated baseline characteristics and maternal and neonatal outcome data for each study participant. The obtained data was then merged with the data on fetal position.

4.15. Data Verification

The study data were collected from two sources, the scan data collected by the research midwives and outcome data from the hospital medical system. The scan data were initially validated by an independent clerk, who inspected all the scans, indentified the accurate fetal position and entered it into a specifically designed database. A researcher then checked all 1250 entered scans for accuracy. Missing data that was identified was retrieved and entered. Similarly a researcher inspected all the outcome data comparing dates of scan and delivery to ensure accuracy. Missing data on delivery outcomes was obtained from electronic medical records or, maternity notes which were retrieved and thus data was obtained or clarified. Following this, both the scan data and the requested outcome data was merged into an excel spreadsheet and transported into STATA, a statistical package which allowed subsequent analysis.

4.16. Sample Size

There were no data available regarding SVD rates for the LOA position at the onset of labour; therefore, the sample size of the study was initially computed using the information available on the proportion of fetuses that present in the OP position at the onset of labour. The prevalence of the OP position at the onset of labour was anticipated to be 10% (Gardberg et al., 1998, Gardberg and Tuppurainen, 1994, Fitzpatrick et al., 2001, Sizer and Nirmal, 2000, Neri et al., 1995, Faber, 1998) and it was assumed that 50% of those presenting in the OP position at the onset of labour would deliver vaginally (Pearl 1993).

To detect an absolute difference of 20% in SVD rates between those that present in the OP position at the onset of labour and those that do not present in the OP position, with a significance level of 5% (alpha) and power (1-beta) of 90% at least 125 women with fetuses in the OP position at the onset of labour were required. As the prevalence of the OP position was 10% a total of 1250 women were required, that is 125 OP positioned fetuses and 1125 non-OP positioned fetuses. This calculation actually provided more than 90% power as the adjustment was conservative. This sample size allowed a smaller absolute difference, of 15%, between the two groups to be detected with 89% power.

For the employed sample size of 1250, power calculations were performed using SVD rates among fetuses in the LOA position at the onset of labour as the outcome, and various combinations of other assumptions. From existing data, an estimate for the local SVD rate for nulliparous women was 57% (BWH, 2007). For a range of SVD rates (40%, 45%, 50%, 55%, 60%, 65%, 70%, 75% and 80%) for fetuses in the LOA position at the onset of labour, the power was calculated using 5%, 7.5%, 10%, 12.5% and 15% as the prevalence of the LOA position at the onset of labour; the results are shown in Table 4.1. The shaded areas highlight those sections that would allow adequate power to detect effect size.

Table 4.1. Power calculation for SVD outcome under various assumptions of LOA prevalence

		Power when LOA prevalence is:				
Proportion SVD rate for all position	**Proportion SVD rate for LOA position**	**5%**	**7.5%**	**10%**	**12.5%**	**15%**
0.57	0.40	0.7070	0.8724	0.9445	0.9758	0.9895
0.57	0.45	0.4077	0.5738	0.6940	0.7808	0.8439
0.57	0.50	0.1589	0.2278	0.2897	0.3463	0.3989
0.57	0.55	0.0380	0.0460	0.0525	0.0583	0.0637
0.57	0.60	0.0503	0.0647	0.0772	0.0887	0.0998
0.57	0.65	0.1895	0.2818	0.3639	0.4375	0.5040
0.57	0.70	0.4689	0.6607	0.7854	0.8651	0.9159
0.57	0.75	0.7878	0.9336	0.9794	0.9936	0.9980
0.57	0.80	0.9648	0.9971	0.9998	1	1

4.17. Data Analysis

Analysis of the data was undertaken; initially descriptive statistics of baseline characteristics were calculated and viewed in a descriptive format. This allowed observation of frequencies, percentages, means, median and standard deviation for the demographic data. By creating these parameters the data could be described and synthesized, highlighting measures of central tendency. This facilitated a general understanding of the data set and description of the characteristics of the study sample. Such exploration of the demographic data helped to highlight the representativeness of the sample population to the total population.

The data set contained mainly nominal data (categorical variables with no order) and some binary data. The relationship between fetal position and the primary outcome measure (mode of delivery) was explored using cross tabulations and statistical tests. Further tabulations using secondary outcomes were also produced and statistical tests performed. The statistical tests employed were chi-squared and t-Tests, as appropriate, to determine if observed differences were statistically significant.

A Kappa test was carried out to investigate the agreement between spine and occiput measures. Analysis was performed to demonstrate the proportion of cases where both the spine and occiput in a single participant matched for alignment. The Kappa test gives a statistic expressing this agreement and generates a *p*-value allowing interpretation of its significance. The commonly cited scale of kappa interpretation is shown in Table 4.2.

Table 4.2. Standard interpretation of Kappa statistic (Viera and Garrett, 2005)

Kappa statistic	Interpretation
<0	No agreement
0.0-0.20	Slight agreement
0.21-0.40	Fair agreement
0.41-0.60	Moderate agreement
0.61-0.80	Substantial agreement
0.81-1.00	Almost perfect agreement

Cross tabulation were compiled to analyse association between each fetal position against the LOA position, and between spontaneous and non-spontaneous vaginal delivery outcomes. This allowed calculation of relative risk with corresponding 95% confidence intervals and p-values to determine statistical significance.

As the main aim of this observational study was to search for association as well as direction of association between the investigating variables, regression analysis was deemed necessary. Categorical data was modelled using logistic regression to adjust for variables known to have an effect on SVD rates.

CHAPTER 5

RESULTS

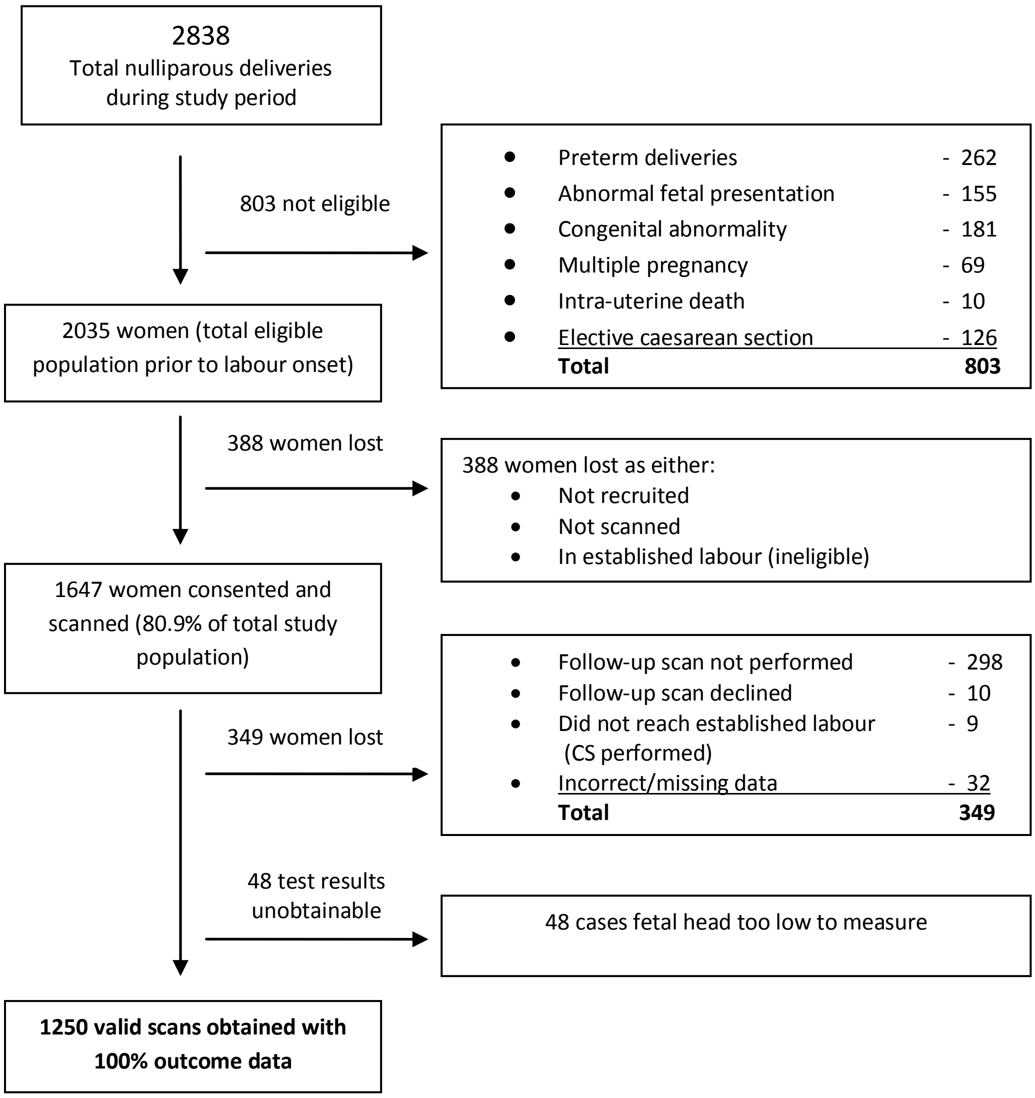
5.1. Assembly of Study Cohort

The study obtained full scan and outcome data for the required 1250 participants within the 18 month study period of April 2007 to September 2008. During the study period, there were 2838 births to nulliparous women at the BWH. Of these deliveries, 803 women were not eligible as they did not meet one or more of the study eligibility criteria.

Of the eligible population of 2035 women prior to labour onset, 80.9% (1647/2035) consented to take part in the study and were scanned for the study. The remaining 388 women were lost as they either did not consent or consented and were not scanned or arrived at the hospital in established labour and were therefore ineligible for the study. No recorded data was available on the proportion of women admitted in established labour at BWHCT during the study period or at any other period. It was therefore difficult to estimate what proportion of the 388 women were ineligible as they arrived in established labour and what proportion were not consented or were not scanned.

Of the 1647 women who consented and were scanned 349 were subsequently lost as shown in Figure 5.1. In a further 48 cases the test result was technically unobtainable, as the fetal head was too low to determine fetal occiput position, these women were subsequently removed from the study. The final number of women for whom a valid scan was available and full outcome data acquired was 1250. By recruiting within a time frame of 18 months this inferred that the study sample consisted of a minimum of 61.4% of the total eligible population or a maximum of 75.9% of the total population if presumed that all or none of the 388 women lost were actually ineligible as they had arrived in established labour. Figure 5.1 outlines the assembly of the study cohort.

Figure 5.1. Recruitment of study sample



5.2. Maternal Characteristics

All women recruited to the study were nulliparous defined as having no live births or previous pregnancies exceeding the first trimester. In terms of gravida, 95% of the sample were gravida one or gravida two and had either never been pregnant before or previously had 1 first trimester miscarriage. The remaining 5.0% of the study recruits had 2 or more miscarriages with a single participant having seven 1^{st} trimester miscarriages. The mean age for the study participants was 26 years. The largest group was between the ages of 20-25 and accounted for 31.3% of the total study population.

The largest ethnic group in the study was the White British group that made up almost 56% of the total sample population. The second largest group of participants was the Pakistani group at 15%, followed by the Indian ethnic group (6.3%).

The country of origin showed that almost 72.0% of the population were from the United Kingdom. This was followed by 7.7% of the population which originated from Pakistan and 2.5% from India. The remaining 6.5% consisted of smaller groups of women who originated from Poland, China, Yemen, Bangladesh and Ireland, 11.4% of the sample however consisted of the ‘other group’.

The BMI categories showed that the majority of women (50.8%) were within the normal BMI range (18.5 -29.9). Almost 28% of the sample population had a BMI that was classified as over-weight. 16.0% of women had a BMI that was classed as obese, with 1.7% of women in the very obese category. The mean height of the study population was 161cm and the mean weight was 67kg.

The mean gestational age at labour onset for women in the study population was 40.25 weeks. Of the total sample population 62.6% of women had spontaneous onset of labour. Regular contractions accounted for almost 50.0% and surgical induction was the least common method of labour onset accounting for 1.9%. The majority of women (86.5%) delivered at the consultant unit with 13.0% of women delivering at the midwife led-birth centre. The characteristics of the study sample are outlined in Table 5.1.

Table 5.1. Maternal characteristics

Variable			
	1	967	(77.4)
Gravida	2	215	(17.2)
Frequency (%)	3	47	(3.8)
	4	21	(1.7)
Age (Years)	<20	232	(18.6)
Frequency (%)	21-25	391	(31.3)
	26-30	344	(27.5)
	31-35	206	(16.5)
	Over 35	77	(6.1)
	White-British	699	(55.9)
	Asian/Asian British-Pakistani	186	(14.9)
	Asian/Asian British-Indian	79	(6.3)
	Black/Black British-African	29	(2.3)
	Mixed-White& Black-Caribbean	28	(2.2)
	Chinese	28	(2.2)
Ethnicity	Black/Black British-Caribbean	26	(2.1)
Frequency (%)	Asian/Asian British-Bangladeshi	22	(1.8)
	Asian/Asian British-Other	21	(1.7)
	White-Irish	13	(1.0)
	Mixed-Other	8	(0.6)
	Black/Black-British-Other	8	(0.6)
	Mixed-White& Black-African	6	(0.5)
	Other Ethnic Group/Not stated	97	(7.7)

Table 5.1. Maternal characteristics (Continued)

Country of Origin *Frequency (%)*	United Kingdom	899	(71.9)
	Pakistan	97	(7.8)
	India	32	(2.6)
	Poland	21	(1.7)
	China	18	(1.1)
	Yemen	17	(1.4)
	Bangladesh	14	(1.1)
	S. Ireland	10	(0.8)
	Other	142	(11.4)
BMI *Frequency (%)*	≤ 18.4	44	(3.2)
	18.5-24.9	636	(50.8)
	25-29.9	349	(27.9)
	30-40	200	(16.0)
	≥40	21	(1.7)
Height (cm) *mean (sd)*		161.80	(6.98)
Gestation (Weeks) *mean (sd)*		40.25	(1.2)
Onset of Labour *Frequency (%)*	Regular Contractions	614	(49.1)
	Prostin	357	(28.6)
	S.R.O.M	164	(13.1)
	Surgical Induction & Prostin	33	(2.6)
	Surgical Induction & Oxytocic	31	(2.5)
	Oxytocic Drugs	25	(2.0)
	Surgical Induction	24	(1.9)
	ARM	2	(0.2)
Place of Delivery *Frequency (%)*	BWH (Consultant Unit)	1,082	(86.5)
	BWH (Birth Centre)	168	(13.4)

5.3. Neonatal Characteristics

Of the total study sample all but one neonate was born alive, with one fetal intra-partum intra-uterine death throughout the study period. The sexes were almost equally distributed with 50.8% male and 49.2% female.

The mean birth weight was approximately 3.34kg, with the mean head circumference of 34cm and mean length of 51cm, Table 5.2 outlines the neonatal baseline characteristics.

Table 5.2. Neonatal characteristics

Variable		
Sex-Boy *Frequency (%)*	635	(50.8)
Birth Weight (g) *mean (sd)*	3353.85	(488.24)
Head Circumference (cm) *mean (sd)*	34.14	(1.50)
Length (cm) *mean (sd)*	51.78	(3.10)

5.4. Maternal Outcomes

The primary outcome measure being investigated was mode of delivery. SVD was the most common mode of delivery accounting for 52.9% of all deliveries. This was followed by the emergency CS rate which accounted for 20.4% of all deliveries, with over 14% undergoing ventouse assisted delivery and 12.3% undergoing forceps delivery.

Almost 41% of the study population required no augmentation; this was followed by combined ARM and syntocinon that was used by 22.9% of the study population. ARM and syntocinon only use had a reasonably similar rate of 18.1% and 18.4%.

The mean duration of the first, second and third stage and duration of membrane rupture were 8.8 hours, 62 minutes, 9.7 minutes and 15.9 hours. 96.0% of the study population used analgesia during labour with entonox, Pethidine and epidural being the most frequently used forms of pain relief. A substantial number of women would however, have used more than one form of pain relief throughout labour and delivery. Maternal outcomes from the study are presented in Table 5.3.

Table 5.3. Maternal outcomes of study population

Variable			
	Spontaneous Vaginal Delivery	661	(52.9)
Mode of Delivery	Ventouse	180	(14.4)
Frequency (%)	Forceps	154	(12.3)
	Emergency CS	255	(20.4)
	None	508	(40.6)
Augmentation	ARM	226	(18.1)
Frequency (%)	ARM & Syntocinon	287	(22.9)
	Syntocinon	229	(18.4)
Duration of First Stage (mins) *mean (sd)*		529.44	(479.55)
Duration of Second Stage (mins) *mean (sd)*		62.27	(49.84)
Duration of Third Stage (mins) *mean (sd)*		9.73	(21.38)
Duration of Membrane Rupture (mins) *mean (sd)*		954.32	(1312.92)
TENS *Frequency (%)*		126	(10.1)
Water *Frequency (%)*		77	(6.2)
Entonox *Frequency (%)*		1,053	(84.2)
Pethidine *Frequency (%)*		540	(43.2)
Epidural *Frequency (%)*		489	(39.1)
Spinal *Frequency (%)*		162	(13.0)
Pudendal *Frequency (%)*		10	(0.8)
GA *Frequency (%)*		42	(3.4)

5.5. Neonatal Outcomes

Outcomes relating to the condition of the neonate at delivery were expressed by the Apgar score. The Apgar scores for the neonates showed a mean of 8.5 after 1 minute and 9 after 5 minutes, indicating that the majority of neonates would not have required resuscitation. This is confirmed as 82.6% of the neonates required no resuscitation with facial oxygen being the most common method of resuscitation at 6.0%.

Table 5.4. Neonatal outcomes of study population

Variable			
Apgar Score at 1 min *mean (sd)*		8.50	(1.23)
Apgar 0-3 *frequency* (%)		28 (2.2)	
Apgar 4-7		142 (11.4)	
Apgar 8-10		1080 (86.4)	
Apgar Score at 5 mins *mean (sd)*		9.13	0.62)
Apgar 0-3 *frequency* (%)		2 (0.20)	
Apgar 4-7		16 (1.3)	
Apgar 8-10		1232 (98.5)	
Resuscitation *Frequency (%)*	None	1,032	(82.6)
	Suction Only	61	(4.8)
	Facial Oxygen	75	(6.0)
	Bag, Mask & Suction	54	(4.3)
	Mask & Drugs	2	(0.2)
	Intubation & Drugs	1	(0.1)
	Not known	1	(0.1)

5.6. Distribution of Fetal Occiput Position

This section will look at the proportional distribution of fetal occiput and spine position as retrieved from the study data. Table 5.5 displays the frequency of fetal occiput position as that determined amongst the 1250 study recruits.

Table 5.5. Frequency of fetal occiput position

Fetal occiput position	Frequency (n)	Percentage (%)
LOA	155	12.4
ROA	47	3.8
DOA	95	7.6
LOL	343	27.4
ROL	239	19.1
LOP	167	13.4
ROP	149	11.9
DOP	55	4.4
Total	**1250**	**100 (%)**

Table 5.5 demonstrates that the collective anterior fetal occiput positions accounted for 23.7% of the total positions, with the LOA position being the most common anterior position (12.4%). The LOA position was three times more common than the ROA position (3.8%).

The lateral positions were the most frequent occurring fetal occiput position at 46.5% of women in the study showing to have either of the lateral positions. This is despite there being only 2 variations in the lateral positions (LOL & ROL) compared to 3 variations in both the anterior (LOA, ROA &DOA) and posterior group (DOP, ROP & LOP). The most frequently occurring fetal occiput position was the LOL position at 27.4%.

The collective posterior positions accounted for 29.7% of the total occiput presentations, consequently the second largest group. The LOP position was the most common posterior position at 13.4%, followed by the ROP position at 11.9%. Comparatively the DOP position had a noticeably low rate of occurrence at only 4.4%.

5.7. Distribution of Fetal Spine Position

Fetal spine position was also recorded as a position indicator; such observations were deemed necessary as it is often thought that in clinical practice both the spine and occiput are used interchangeably to define position.

Table 5.6. Frequency of fetal spine position

Fetal spine position On ultrasound	Frequency (n)	Percentage (%)
LspA	229	18.3
RspA	81	6.5
DspA	75	6.0
LspL	343	27.4
RspL	228	18.2
LspP	110	8.8
RspP	142	11.4
DspP	42	3.4
Total	**1250**	**100**

It is apparent from Table 5.6 that there are some similarities and some differences compared to the prevalence of the fetal occiput positions (refer to Table 5.5. for occiput prevalence).

The lateral positions in the fetal spine group were most common at 45.6%, which was similar to that observed in the fetal occiput groups. The LspL position was again the most common fetal position making up 27.4% of the total spine positions. The LspA group was the second most common spine position (18.3%), the RspL group was next with an absolute difference of only 0.1% between the LspA group.

Differences were observed amongst the distribution of the anterior and posterior positions in relation to that which was observed in the occiput groups. In the occiput groups the posterior positions were more common compared to the anterior positions, the converse was observed in the spine group. That is, the spine presented anteriorly 30.8% of the time compared to 23.7% of the time in the occiput group. When observing the percentage of posterior spine occurrence a rate of 23.5% was observed, this was compared to 30% that was noted in the occiput group.

The least common position amongst the spine presentations was the DspP position accounting for only 3.3% of the group, whilst it was the ROA position that was least common in the occiput group.

5.8. Distribution of Combined Fetal Occiput and Spine Position

Table 5.7 shows the position distribution when fetal occiput and spine position are combined to create combination grouping that is, the absolute position of the fetus.

Table 5.7. Distribution of combined fetal occiput and spine position

	Fetal occiput position n (%)								
Spine Position	**LOA**	**ROA**	**DOA**	**LOL**	**ROL**	**LOP**	**ROP**	**DOP**	**Total**
LspA	121 (78.1)	-	19 (20.0)	73 (21.3)	-	16 (9.6)	-	-	229 (18.3)
RspA	1 (0.7)	28 (59.6)	15 (15.8)	-	32 (13.4)	-	5 (3.4)	-	81 (6.5)
DspA	7 (4.5)	5 (10.6)	59 (62.1)	2 (0.6)	-	-	2 (1.34)	-	7 5 (6.0)
LspL	25 (16.1)	-	1 (1.1)	229 (66.8)	3 (1.3)	80 (47.9)	-	5 (9.1)	343 (27.4)
RspL	-	13 (27.7)	1 (1.1)	3 (0.9)	160 (67)	-	47 (31.5)	4 (7.27)	228 (18.2)
LspP	1 (0.7)	-	-	31 (9.0)	-	56 (33.5)	3 (2.0)	19 (34.6)	110 (8.8)
RspP	-	1 (2.1)	-	3 (0.9)	42 (17.6)	2 (1.2)	82 (55.0)	12 (21.8)	142 (11.4)
DspP	-	-	-	2 (0.6)	2 (0.8)	13 (7.8)	10 (6.7)	15 (27.3)	42 (3.4)
Total %	**155 (100)**	**47 (100)**	**95 (100)**	**343 (100)**	**239 (100)**	**167 (100)**	**149 (100)**	**55 (100)**	**1250 (100)**

Combination grouping of the fetal spine and fetal occiput showed that there were majority combination groups, uncommon groups and several combination groups that appear to be incompatible. What is apparent is that out of the 8 combined fetal positions, 6 positions appear to share position alignment. That is, in the majority of cases when the occiput presents in a certain position (e.g. LOA) the spine in the majority of cases will also occupy the same position abdominally (e.g. LspA). Therefore in the majority of cases pelvic examination to determine occiput presentation should be synonymous to spine position on abdominal examination. Alignment ranged from 55% in the ROP&RspP to 78% in the LOA&LspA group.

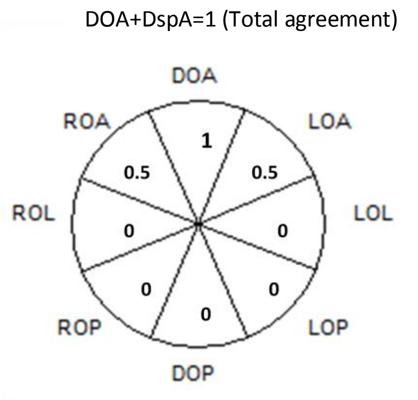
The two positions that did not share occiput and spine alignment were the DOP&DspP combination, and the LOP&LspP combination. The most frequently occurring combination for the DOP position was the LspP, and for the LOP position was the LspL spine position. With the two combination groups that did not share position alignment, in both cases they were posterior occiput positions that did not share alignment with the corresponding spine position.

The most frequently occurring combination group was the occiput LOL with spine LspL group (LOL&LspL). This was followed by the ROL&RspL group, demonstrating that the lateral positions were the most frequently occurring fetal positions overall. The third most common combination group was the LOA&LspA. There were several combination groups that had a frequency of 0, that is, of the 1250 scans performed this combination of spine and occiput position did not occur.

A weighed Kappa test allowed a Kappa statistic to be reported which indicated the magnitude of agreement between the two observations (Viera and Garrett, 2005). The Kappa statistic allowed the magnitude of agreement between fetal occiput and spine position to be assessed.

To calculate the statistic, agreement was categorised as 1 for total agreement of spine and occiput position (e.g. LOA + LspA = 1). When the spine position was one either side from total agreement 0.5 was awarded, the remaining combinations further then the first immediate position either side were awarded 0. Figure 5.2 expresses the allocation used to calculate the Kappa statistic.

Figure 5.2. Distribution of score used to calculate Kappa Statistic (example DOA and DspA)



Using the above distribution the following Kappa statistic was calculated.

Agreement	Expected Agreement	Kappa	P-Value
77.7%	29.4%	0.68	p<0.001

The Kappa test showed that the expected agreement through chance alone was calculated to be 29.4%, the actual agreement was 77.7%, with a Kappa statistic of 0.68 and a p-value of <0.001. Viera and Garrett (2005) Kappa interpretation of a statistic of 0.68 translates to ‘substantial agreement’ between occiput and spine position.

In relation to clinical practice ‘substantial agreement’ would suggest that in the majority of cases determining spine position would in the greater part express the occiput position.

5.9. Fetal Position and Mode of Delivery

The primary outcome measure being investigated was mode of delivery, categorised as SVD, ventouse deliveries (VD), all forceps deliveries (FD) and emergency caesarean sections (CS). Table 5.8 demonstrates the association between fetal occiput position and mode of delivery, in order to investigate if any one fetal position was associated with an increased likelihood of SVD, specifically the LOA position.

Table 5.8. Mode of delivery with fetal occiput position

	Mode of delivery				
Fetal occiput Position	**SVD n (%)**	**VD n (%)**	**FD n (%)**	**CS n (%)**	**Total n (%)**
LOA	77 (49.7)	25 (16.1)	25 (16.1)	28 (18.1)	155 (100)
ROA	26 (55.3)	6 (12.8)	7 (14.9)	8 (17.1)	47 (100)
DOA	56 (59.0)	16 (16.8)	7 (7.4)	16 (16.8)	95 (100)
LOL	179 (52.2)	50 (14.6)	45 (13.1)	69 (20.1)	343 (100)
ROL	127 (53.1)	37 (15.5)	18 (7.5)	57 (23.9)	239 (100)
LOP	95 (56.9)	18 (10.8)	24 (14.4)	30 (18.0)	167 (100)
ROP	75 (50.3)	19 (12.8)	20 (13.4)	35 (23.5)	149 (100)
DOP	26 (47.3)	9 (16.4)	8 (14.6)	12 (21.8)	55 (100)
Total	**661 (52.9)**	**180 (14.4)**	**154 (12.3)**	**255 (20.4)**	**1250 (100)**

The rate of SVD in association with fetal position ranged from 47.3% to 59.0%, with the DOP position having the lowest rate and the DOA position having the highest SVD rate. The LOA position had a SVD rate of 49.7%, the second lowest amongst all the positions. Comparatively, the LOP position had a SVD rate of 56.9%, the second highest rate of SVDs.

For VD's the DOA position had the highest rate at 16.8% and the LOP position had the lowest rate at 10.8%. The LOA position had a VD rate of 16.1% which was the third highest.

The FD rate ranged from 7.4% to 16.1% amongst the various occiput positions. The LOA position had the highest rate followed by the ROA position at 14.9%. The DOA position which had the lowest rate at 7.4% was followed by the ROL position at 7.5%.

The CS rates amongst the groups ranged from 16.8% in the DOA group to 23.9% in the ROL group. The LOA position had a CS rate of 18.1%.

5.9.1 Mode of delivery with LOA or non-LOA fetal occiput position

The main comparison within this study was the association between LOA position and incidence rate of SVD relative to all other positions. Table 5.9 shows the results of the analysis of LOA and non-LOA fetal position for SVD.

Table 5.9. Mode of delivery with LOA and non-LOA fetal occiput position

	LOA position n (%*)	Non-LOA position n (%*)	RR (95% CI)	P Value
SVD	77 (49.7)	584 (53.3)	0.93 (0.78,1.10)	0.39
Non SVD	78 (50.3)	511 (46.7)		

*= Percentage from total LOA/Non-LOA positions

The LOA position had a lower SVD rate at 49.7%, comparative to the non-LOA group that had an SVD rate of 53.3%, with a RR of 0.93. A chi-squared test was performed to determine if the observed difference between the LOA and non-LOA group were statistically significant, showing that it was not (p=0.39).

5.9.2. Mode of delivery with fetal occiput cavity position

Fetal position was also categorised by occupying cavity, that being cavity grouped anterior, posterior or lateral positions. Analysis between the combined cavity groups was performed to determine if differences in relation to mode of delivery were present. Table 5.10 presents the data on mode of delivery with all anterior positions (LOA&ROA&DOA= OA) against all lateral position (LOL&ROL= OL) and all posterior positions (LOP&ROP&DOP= OP).

Table 5.10. Grouped occiput cavity position (OA, OL, and OP) and mode of delivery

	Mode of delivery				
Grouped fetal occiput Position	**SVD n (%)**	**VD n (%)**	**FD n (%)**	**CS n (%)**	**Total n (%)**
OA	159 (53.5)	47 (15.8)	39 (13.1)	52 (17.5)	297 (100)
OL	306 (52.6)	87 (15.0)	63 (10.3)	126 (21.7)	582 (100)
OP	196 (52.8)	46 (12.4)	52(14.0)	77 (20.8)	371 (100)
Total	**661 (52.9)**	**180 (14.4)**	**154(12.3)**	**255 (20.4)**	**1250 (100)**

Essentially it appeared that the results amongst the groups were reasonably similar with the absolute percentage difference ranging from 2-4.1% between each group and each delivery category. A chi-squared test showed that the observed differences between the three groups were not statistically significant (p=0.49).

One of the study objectives was to explore if any fetal position, specifically the LOA position at the onset of labour was associated with improved birth outcomes, in particular mode of delivery. In view of this, a further individual breakdown of each fetal position against all other positions was explored to determine if there were any differences between the individual occiput positions in relation to SVD. Table 5.11 presents the results of the analysis.

Table 5.11. Analysis of fetal occiput position and mode of delivery

Fetal Position	SVD n (%*)	Non-SVD n (%*)	Relative Risk (RR)	95% CI	P-value
LOA (against all other fetal positions)	77 (6.2)	78 (6.2)	0.93	0.78-1.10	0.39
ROA (against all other fetal positions)	26 (2.0)	21 (1.7)	1.04	0.80-1.36	0.73
DOA (against all other fetal positions)	56 (4.5)	39 (3.1)	1.12	0.94-1.34	0.21
LOL (against all other fetal positions)	179 (14.3)	164 (13.1)	0.98	0.87-1.10	0.76
ROL (against all other fetal positions)	127 (10.2)	112 (9.0)	1.00	0.88-1.14	0.92
LOP (against all other fetal positions)	95 (7.6)	72 (5.8)	1.08	0.94-1.25	0.26
ROP (against all other fetal positions)	75 (6.0)	74 (5.9)	0.94	0.79-1.11	0.50
DOP (against all other fetal positions)	26 (2.1)	29 (2.3)	0.88	0.66-1.18	0.39

*= Percentage of total population (1250)

The results showed that it was the DOA position that had a 12% higher rate of SVD compared to all other positions. The 95% confidence interval however ranged from 0.94-1.34 and a *p*-value of 0.21 demonstrating that the observed difference was not statistically significant.

The DOP position appeared to have the least favoured outcome with a 12% lower rate of SVD compared to all other positions. This result however was not statistically significant as the 95% confidence interval was 0.66-1.18 and the *p*-value was 0.39.

Table 5.11 illustrated that of the 8 positions 3 appeared to have a favoured RR (ROA, DOA, LOP), the remaining positions appeared to show less favoured RR. Of the 8 fetal positions none showed a statistically significant difference relative to all the others.

5.9.3. Mode of delivery with fetal spine position

Since spine position was also recorded as a position indicator, Table 5.12 explores the association of mode of delivery comparative to fetal spine position.

Table 5.12. Mode of delivery with fetal spine position

	Mode of delivery				
Fetal Spine Position	**SVD n (%)**	**VD n (%)**	**FD n (%)**	**CS n (%)**	**Total n (%)**
LspA	131 (57.2)	36 (15.7)	29 (12.7)	33 (14.4)	229 (100)
RspA	47 (58.0)	12 (14.8)	5 (6.2)	17 (21.0)	81 (100)
DspA	38 (50.7)	14 (18.6)	9 (12.0)	14 (18.7)	75 (100)
LspL	172 (50.1)	47 (13.7)	49 (14.3)	75 (21.9)	343 (100)
RspL	127 (55.7)	30 (13.2)	21 (9.2)	50 (21.9)	228 (100)
LspP	60 (54.6)	14 (12.7)	14 (12.7)	22 (20.0)	110 (100)
RspP	62 (43.6)	23 (16.2)	20 (14.1)	37 (26.1)	142 (100)
DspP	24 (57.1)	4 (9.5)	7 (16.7)	7 (16.7)	42 (100)
Total	**661 (52.9)**	**180 (14.4)**	**154(12.3)**	**255 (20.4)**	**1250 (100)**

In the occiput group the DOA position had the highest rate of SVD's at 58.9%; however in the spine group the corresponding DspA position actually had the second lowest rate of SVD's at 50.7%. It was the RspA group that had the highest rate of SVD's at 58.0%. This was followed by the LspA group at 57.2% and surprisingly the DspP had an almost similar rate of 57.1%. Within the spine groups it was in fact the RspP position that actually had the lowest rate of SVD's at 43.6%.

The VD rates ranged from 9.5% in the DspP group to 18.6% in the DspA group. This result is similar to that which was observed with the occiput group. It was also noted that the lowest rate of VD was amongst the DspP position in the spine group and LOP position in the occiput group.

The FD rates showed that the RspA position had the lowest rate at 6.2%. The highest rate was observed amongst the DspP group at 16.7%. Interestingly the following groups that had the highest rate of FD's were the LspL (14.3%), LspP (12.7%) and the LspA position (12.7%) suggesting that foetuses that occupied the left quadrant appeared to have a higher incidence of FD.

The CS rate ranged from 14.4% to 26.1%, with the lowest CS rate amongst the LspA group and the highest rate amongst the RspP group.

5.9.4. Mode of delivery with LspA and non-LspA fetal spine position

As the LspA position is the corresponding position to the LOA occiput position further analysis in relation to mode of delivery was undertaken.

Table 5.13. Mode of delivery with LspA and non-LspA fetal spine position

	LspA position n (%*)	Non-LspA position n (%*)	RR(CI)	P Value
SVD	131 (57.2)	530 (51.9)	1.10 (0.97,1.25)	0.14
Non SVD	98 (42.8)	491 (48.1)		

*= Percentage of total LspA/Non-LspA positions

The LspA position had a higher SVD rate of 57.2% compared to all non-LspA groups (51.9%) with an absolute percentage difference of 5.3% between the two groups. The observed differences however were not statistically significant (*p*=0.14).

A further individual breakdown of each fetal spine position against all other positions was explored to determine if there were any individual differences between the spine positions that maybe associated with an increased rate of SVD. Table 5.14 summarises the analysis performed and presents the findings.

Table 5.14. Analysis of fetal spine position and mode of delivery

	Mode of delivery				
Fetal Position	**SVD n (%*)**	**Non-SVD n (%*)**	**Relative Risk (RR)**	**95% CI**	**P-value**
LspA (against all other fetal positions)	131 (10.5)	98 (7.8)	1.10	0.97-1.25	0.14
RspA (against all other fetal positions)	47 (3.8)	34 (2.7)	1.10	0.91-1.34	0.33
DspA (against all other fetal positions)	38 (3.0)	37 (2.9)	0.95	0.75-1.20	0.69
LspL (against all other fetal positions)	172 (13.8)	171 (13.7)	0.93	0.82-1.05	0.23
RspL (against all other fetal positions)	127 (10.2)	101 (8.1)	1.06	0.93-1.21	0.34
LspP (against all other fetal positions)	60 (4.8)	50 (4.0)	1.03	0.86-1.23	0.71
RspP (against all other fetal positions)	62 (5.0)	80 (6.4)	0.80	0.66-0.98	0.01**
DspP (against all other fetal positions)	24 (1.9)	18 (1.4)	1.08	0.82-1.41	0.57

*= Percentage from total population (1250)
**= Statistically Significant

The results showed that both the LspA position and the RspA position appeared to have a 10% higher rate of SVD compared to all other spine positions, the differences were not statistically significant. The RspL, LspP and the DspP position also had an increased rate of SVD compared to all others, the percentage ranged from 3% to 8%, the differences however were not statistically significant.

The RspP position appeared to have the least favoured outcome with the relative risk of 0.80 suggesting that the RspP position had a 20% lower rate of SVD compared to all non-RspP positions. This was the largest difference observed amongst the occiput and spine groups.

The confidence interval ranged from 0.82-0.98 with a p-value of 0.01, therefore the observed differences between the RspP position compared to all others was statistically significant.

5.9.5. Logistic regression analysis (Fetal occiput position and mode of delivery)

In order to explore further the relationship between the LOA fetal position with mode of delivery regression analysis was undertaken. Specifically 'multiple logistic regression' allowed the investigation of relationships between a dependant and multiple independent variables, thus allowing both the strength and pattern of association to be explored. A model of logistic regression was applied which modelled SVD with position, allowing odds ratios to be calculated for the different positions in relation to LOA. The results are outlined in Table 5.15:

Table 5.15: Logistic regression analysis (SVD and fetal occiput position)

Fetal Position Compared to LOA	Odds Ratio (OR)	95% CI	P-value
LOA	Reference		
ROA	1.25	0.65-2.41	0.48
DOA	1.45	0.88-2.44	0.15
LOL	1.10	0.76-1.62	0.60
ROL	1.15	0.77-1.72	0.50
LOP	1.34	0.86-2.07	0.48
ROP	1.03	0.65-1.61	0.90
DOP	0.91	0.49-1.68	0.75

The logistic regression model applied showed that comparative to the LOA position, although differences in SVD rates were observed they were not statistically significant.

Further modelling was undertaken to adjust for variables known to have an effect on SVD rates. These were maternal age, epidural analgesia, duration of labour and fetal birth weight, specifically:

- Increasing maternal age is associated with an increase in rates of CS delivery (Sharma et al., 2009, Kirchengast, 2007).
- Epidural analgesia is associated with an increase in instrumental delivery rate (Anim-Somuah et al., 2010, Sharma et al., 2009, Leong et al., 2000).
- Duration of labour is associated with an increase in CS delivery (Abu-Heija and Zayer, 1998, El-Hamamy and Arulkumaran, 2005, Gillford et al., 2000).
- Neonatal birth weight is associated with an increase in CS delivery (Sharma et al., 2009, Mocanu et al., 2000).

As expected all four variables within the study data set were analysed and were shown to be associated with SVD with results that were statistically significant. The analysis verified the data set showing that the obtained data supports known trends of association and also enabled the modelling of these variables against the LOA position to determine if these factors influenced rates of SVD. The results are shown in table 5.16.

Table 5.16: Regression Analysis- Modelling against trends of known association

Variable (coding)	Odds Ratio	95% Confidence Interval	P-Value
Age (yearly interval)	0.93	(0.91-0.95)	<0.001
Epidural (yes/no)	0.22	(0.16-0.29)	<0.001
Labour duration (Hourly interval)	0.97	(0.95-0.98)	<0.001
Neonatal birth weight (per 100gm change)	0.95	(0.96-0.98)	<0.001
*ROA	1.41	(0.63-3.18)	0.39
*DOA	1.89	(0.98-3.65)	0.06
*LOL	1.06	(0.66-1.70)	0.79
*ROL	1.20	(0.72-2.01)	0.47
*LOP	1.50	(0.86-2.26)	0.14
*ROP	1.00	(0.57-1.76)	0.97
*DOP	0.98	(0.45-2.10)	0.96

(*= Comparative to LOA position.)

The analysis performed looked at all fetal occiput positions against the LOA position to determine if known associations would influence rates of SVD. None were found to be statistically significant, but the increase in the SVD rate for the DOA position almost reached statistical significance.

5.10. Labour Augmentation

The following explores the association between fetal occiput position and the secondary outcomes, commencing with labour augmentation. Table 5.17 presents the data on labour augmentation with fetal occiput position.

Table 5.17. Labour augmentation and fetal occiput position

	Labour augmentation				
Fetal occiput position	**None**	**ARM**	**Syntocinon**	**ARM & Syntocinon**	**Total**
LOA	57 (36.8)	34 (21.9)	63 (18.4)	35 (22.6)	155 (100)
ROA	19 (40.4)	6 (12.8)	5 (10.6)	17 (36.2)	47 (100)
DOA	47 (49.5)	15 (15.8)	19 (20)	14 (14.7)	95 (100)
LOL	137 (39.9)	60 (17.5)	63 (18.4)	83 (24.2)	343 (100)
ROL	107 (44.8)	39 (16.3)	35 (14.6)	58 (24.3)	239 (100)
LOP	70 (41.9)	29 (17.4)	35 (21)	33 (19.8)	167 (100)
ROP	54 (36.2)	33 (22.2)	28 (18.8)	34 (22.8)	149 (100)
DOP	17 (30.9)	10 (18.2)	15 (27.3)	35 (22.6)	55 (100)
Total	**508 (40.6)**	**226 (18.1)**	**229 (18.3)**	**287 (23)**	**1250(100%)**

Most women (59.4%) underwent some form of augmentation throughout the labour and/or delivery process. The DOA position had the highest rate of none augmentation at 49.5%. Similarly the lowest rate of none augmentation was observed amongst the DOP group at 30.9%.

The ARM rate ranged from 12.8% in the ROA group to 22.2% in the ROP group. The LOA position had the second highest ARM rate at 21.9%, almost similar to the ROP position. The syntocinon only group showed that the ROA position had the lowest rate of use at 10.6% with the highest rate of syntocinon only use observed in the DOP group (27.3%). The LOA position had a syntocinon augmentation rate of 18.4%, which was amongst the average for the group.

The combined ARM and syntocinon augmentation rates appeared to have a visibly large variation, ranging from 14.7% to 36.1%. The lowest rate was observed in the DOA group, and the highest rate was observed in the ROA group. Interestingly the highest rate of combined augmentation was not observed in a posterior or lateral group but instead in an anterior group. The 36.1% combined augmentation rate for the ROA position did not reflect the general percentage rates. The remaining positions that had the higher rates of combined augmentation appear to remain within the 20% range of which all were below 25%, whilst the ROA position had an absolute percentage difference of 11.1%. The LOA position had an average combined augmentation rate of 22.5%.

5.10.1. Labour augmentation with LOA and non-LOA fetal occiput position.

Table 5.18 presents the data on LOA and non-LOA fetal positions with labour augmentation.

Table 5.18. Labour augmentation with LOA and non-LOA fetal occiput position

	Augmentation method				
Fetal position	**None**	**ARM**	**Syntocinon**	**ARM & Syntocinon**	**Total**
LOA position	57 (36.8)	34 (21.9)	29 (18.7)	35 (22.6)	155 (100)
All non-LOA positions	451 (41.2)	192 (17.5)	200 (18.3)	252 (23.0)	1095 (100)
Total	**508 (40.6)**	**226 (18.1)**	**229 (18.3)**	**287 (23)**	**1250 (100)**

A chi-squared test was performed to see if the observed differences were statistically significant, a p-value of 0.54 was obtained showing that they were not.

5.11. Pain Relief

The exploration of pain relief use in relation to fetal position was complex as each participant may have utilized more than one form of pain relief. Table 5.19 displays the frequency and percentage of each form of pain relief used amongst the individual fetal positions, where frequency refers to the total number of participants who used that particular form of pain relief and percentage referring to the percent use within that particular fetal position.

Table 5.19. Pain relief and fetal occiput position

Fetal occiput position	Entonox n (%)	Pethidine n (%)	Epidural n (%)	Spinal n (%)	TENS n (%)	Water n (%)	Pudendal block n (%)	GA n (%)
LOA	124 (80.0)	71 (45.8)	61 (39.4)	19 (12.3)	9 (5.8)	8 (5.2)	1 (0.7)	6 (3.9)
ROA	40 (85.1)	24 (51.1)	20 (42.6)	6 (12.8)	3 (6.4)	1 (2.1)	1 (2.1)	1 (1.8)
DOA	84 (88.4)	35 (36.8)	40 (42.1)	11 (11.6)	7 (7.4)	6 (6.3)	-	-
LOL	285 (83.1)	127 (37.0)	126 (36.7)	40 (11.7)	39 (11.4)	23 (6.7)	6 (1.8)	13 (3.8)
ROL	205 (85.8)	99 (41.4)	86 (35.9)	35 (14.6)	25 (10.5)	15 (6.3)	2 (0.8)	11 (4.6)
LOP	141 (84.4)	89 (53.3)	66 (39.5)	22 (13.2)	19 (11.4)	12 (7.2)	-	4 (2.4)
ROP	129 (86.6)	69 (46.3)	66 (44.3)	21 (14.1)	18 (12.1)	9 (6.0)	-	6 (4.0)
DOP	45 (81.8)	24 (43.6)	24 (43.6)	8 (14.6)	6 (10.9)	3 (5.5)	-	1 (1.8)

Table 5.19 illustrates that the overall rate of entonox use was fairly similar amongst all the positions, with the rate of use ranging from 80-88.4%. It was the LOA position that had the lowest rate of entonox use with the DOA position having the highest rate of use.

The percentage of women receiving pethidine, ranged from 36.8-53.3%. The lowest use was observed in the DOA group (36.8%) and the highest rate was observed in the LOP group at 53.2%. It was an anterior (DOA) and lateral position (LOL) that had the lowest rates of pethidine use, and a posterior (LOP) and anterior position (ROA) that constituted the highest rates of use. It appeared that it was individual positions that demonstrated an increased or otherwise use of pethidine rather than anterior, lateral, or posterior grouped association at this stage.

The percentage of women receiving epidural analgesia ranged from 35.9% to 44.3% in the ROP group with the lowest rate in the ROL group. It was the two posterior groups that had the higher proportion of epidural use. Similarly it was both the lateral groups that had the lowest percentage use of epidural analgesia with LOL at 36.7% and ROL at 35.9%. The LOA position had an average rate of epidural use (39.3%).

The use of spinal analgesia ranged from 11.6% to 14.6%. The lowest rate of use was observed amongst the DOA and the LOL position that had a virtually similar rate at 11.6% and 11.7%. The highest proportion of spinal analgesia use was amongst the ROL and the DOP positions that both had a percentage of 14.6%. The use of TENS, water, GA and pudendal block were extremely uncommon with a minority proportion of women using such forms of pain relief.

Chi-squared tests were carried out to test whether the proportion of women having or not having a particular form of pain relief was significant across the 8 fetal positions, the results are shown in Table 5.20. The only form of pain relief to show a significant difference was pethidine use amongst women having and not having pethidine across the 8 fetal positions (*p*=0.02).

Table 5.20. Chi-squared analysis of individual forms of pain relief against all fetal positions

Pain relief type	P-value
Entonox	0.66
Pethidine	0.02*
Epidural	0.71
Spinal	0.97
TENS	0.50
Water	0.92
Pudendal block	0.27
General anesthetic	0.53

***statistically significant**

Further analysis of pethidine use was carried out to determine if the observed differences were related to occupying cavity that is, anterior, lateral or posterior grouped association.

Table 5.21. Grouped cavity fetal occiput position (OA, OL, and OP) and pethidine use

Fetal occiput Position	Pethidine used n (%)	Non-Pethidine use n (%)	Total
OA	130 (43.8)	167 (56.2)	297 (100)
OL	226 (38.8)	356 (61.2)	582 (100)
OP	182 (49.1)	189 (50.9)	371 (100)
Total	**538 (43)**	**712 (57)**	**1250 (100%)**

This analysis showed that despite it being both an individual anterior and an individual posterior position that had the highest use of pethidine (see Table 5.19), when categorised into collective anterior, lateral and posterior groups, it was the posterior group that showed increased use of pethidine overall. A chi-squared test suggested that the posterior fetal positions had a significantly higher use of pethidine compared to the anterior and lateral positions (*p*=0.008).

Further analysis was undertaken to determine if specifically the LOA position comparative to all other positions was associated with use of pethidine (Table 5.22).

Table 5.22. Pethidine with LOA against non-LOA fetal occiput position

Fetal occiput Position	Pethidine used n (%)	Non-Pethidine use n (%)	Total
LOA position	71 (45.8)	84 (54.2)	155 (100%)
All non-LOA position	467 (42.7)	628 (57.4)	1095 (100%)
Total	**538 (43)**	**712 (57)**	**1250 (100%)**

Table 5.22 shows that the LOA position had a 3.2% increased rate of pethidine use compared to all other fetal positions, but a chi-squared test showed that this was not statistically significant (*p*=0.46).

5.12. Labour Duration

The duration of labour was analysed at three period points of the labour and delivery process which were:

- duration of the active first stage of labour.
- duration of the second stage of labour.
- duration of membrane rupture.

Table 5.23 presents the data on the duration of the active first stage of labour and all fetal positions.

Table 5.23. Duration of active first stage and fetal occiput position.

Fetal occiput position on ultrasound	**Frequency (n)**	**Mean duration active first stage mins (hrs)**	**Standard deviation (mins)**
LOA	131	533 (8.8)	540
ROA	41	727 (12.1)	604
DOA	82	545 (9.0)	581
LOL	287	487 (8.1)	419
ROL	190	536 (8.9)	526
LOP	139	540 (9.0)	465
ROP	123	531 (8.8)	382
DOP	46	506 (8.4)	363
Total	**1039***		

* 211 women had emergency CS within the first stage of labour, therefore total duration not available.

The ROA position had the longest mean duration of active first stage of labour at 727 minutes, with the shortest mean duration of the first stage of labour observed in the LOL group at 487 minutes.

A regression model was applied which modelled duration of active first stage for each fetal position comparative to the LOA position to determine if differences were observed, the direction of association and if they were statistically significant. None of the 7 positions modelled against the LOA position on duration of active first stage showed a statistically significant difference (p=0.21).

5.12.1. Duration of Second stage

Table 5.24. Duration of second stage of labour and fetal occiput position

Fetal occiput position on ultrasound	Frequency (n)	Mean duration of second stage (mins)	Standard deviation (mins)
LOA	131	55	44
ROA	41	49	45
DOA	82	62	47
LOL	287	64	48
ROL	190	61	52
LOP	139	64	46
ROP	123	66	60
DOP	46	62	45
Total	**1039***		

* 211 women had emergency CS within the first stage of labour, therefore duration for second stage not available.

The mean duration of the second stage of labour ranged from 49 minutes to 66 minutes. The ROA position had the shortest duration of second stage, with the ROP having the longest at 66 minutes. A regression model was applied which modelled duration of second stage for each fetal position to the LOA position to determine if differences were observed and if they were significant. A *p*-value of 0.40 was reported showing that the observed differences were not statistically significant.

5.12.2. Duration of membrane rupture

Table 5.25 outlines the mean duration of membrane rupture for each fetal position.

Table 5.25. Duration of membrane rupture and fetal occiput position

Fetal occiput Position on Ultrasound	Frequency (n)	Mean duration of membrane rupture min (h).	Standard deviation
LOA	155	953 (15.8)	1250
ROA	47	899(14.9)	1326
DOA	95	938(15.6)	1090
LOL	335	993(16.5)	1305
ROL	234	941(15.6)	1453
LOP	166	972(16.2)	1504
ROP	144	819(13.6)	1027
DOP	55	1148(19.1)	1321
Total	**1231***		

* 11 cases where duration of membrane rupture not available.

The table shows that the DOP position had the longest mean duration of membrane rupture at 1148 minutes with the shortest duration observed by the ROP position at 819 minutes. A regression model was applied which modelled duration of membrane rupture for each fetal position comparative to the LOA position. All seven positions when modelled revealed results that were not statistically significant (p=0.86).

5.13. Neonatal Condition at Birth

The condition of the neonate at birth was assessed by Apgar scores at 1 minute and at 5 minutes.

5.13.1. Fetal occiput position and Apgar score at 1 minute

Table 5.26 illustrates the Apgar score at 1 minute in relation to fetal occiput position.

Table 5.26. Apgar score at 1 minute and fetal occiput position

Apgar score at 1 minute

Fetal occiput position	Apgar score 0-3 n (%)	Apgar score 4-7 n (%)	Apgar score 8-10 n (%)	Total n (%)
LOA	4 (2.6)	15 (9.7)	136 (87.7)	155 (100)
ROA	1 (2.1)	9 (19.2)	37 (78.7)	47 (100)
DOA	2 (2.1)	9 (9.5)	84 (88.4)	95 (100)
LOL	5 (1.5)	39 (11.4)	299 (87.2))	343 (100)
ROL	4 (1.7)	22 (9.2)	213 (89.1)	239 (100
LOP	5 (3.0)	18 (10.8)	144 (86.2)	167 (100)
ROP	7 (4.7)	17 (11.4)	125 (83.9)	149 (100)
DOP	0 (0.0)	13 (23.6)	42 (76.4)	55 (100)
Total	**28 (2.2)**	**142 (11.4)**	**1080 (86.4)**	**1250 (100)**

The table indicates that only a small percentage of neonates required immediate resuscitation (2.2%) that had Apgar scores of 0-3 at 1 minute. The ROP position appeared to have the highest incidence at 4.7% with the DOP position having no neonates born with an Apgar score of 3 or less.

11.4% of the total study population had neonates with an Apgar score of 4-7. The DOP position had the highest incidence at 23.6% of neonates with the lowest incidence observed amongst the ROL position at 9.2%.

The majority of neonates did not require any form of resuscitation since 86.4% of neonates had an Apgar score of 8-10 at 1 minute. Generally, the percentages of neonates with Apgar scores between 8-10 were similar amongst the position groups. The percentage ranged from 76.4-89.1%. To analyse the differences further the Apgar score at one minute was assessed against cavity grouped positions of anterior, lateral and posterior fetal positions. This allowed exploration of Apgar score and group association.

Table 5.27. Apgar score at 1 minute with cavity grouped fetal positions.

Apgar score at 1 minute

Fetal occiput position	Apgar score 0-3 n (%)	Apgar score 4-7 n (%)	Apgar score 8-10 n (%)	Total
OA	7 (2.4)	33 (11.1)	257 (86.5)	297 (100)
OL	9 (1.6)	61 (10.5)	512 (88.0)	582 (100)
OP	12 (3.2)	48 (12.9)	311 (83.8)	1080 (100)
Total	**28 (2.2)**	**142 (11.4)**	**1080 (86.4)**	**1250 (100)**

Table 5.27 demonstrated that the overall pattern of distribution remained similar amongst the three cavity groups with the majority of neonates in the Apgar score of 8-10 group. This was followed by a small proportion of neonates in the Apgar score 4-7, and the smallest minority of infants in the Apgar score 0-3 group. A chi-squared test was performed that showed that observed differences were not statistically significant (p=0.33).

5.13.2. Apgar score at 5 minutes

A second assessment of the Apgar score took place at 5 minutes to determine the condition of the neonate for the second time and need for resuscitation.

Table 5.28. Apgar score at 5 minutes and fetal occiput position

Apgar score at 5 minutes

Fetal occiput position	Apgar score 0-3 n (%)	Apgar score 4-7 n (%)	Apgar score 8-10 n (%)	Total n (%)
LOA	0 (0.0)	1 (0.7)	154 (99.4)	155 (100)
ROA	0 (0.0)	0 (0.0)	47 (100)	47 (100)
DOA	0 (0.0)	0 (0.0)	95 (100)	95 (100)
LOL	1 (0.3)	5 (1.5)	337 (98.3)	343 (100)
ROL	0 (0.0)	1 (0.4)	238 (99.6)	239 (100)
LOP	1 (0.6)	5 (3.0)	161 (96.4)	167 (100)
ROP	0 (0.0)	3 (2.0)	146 (98.0)	149 (100)
DOP	0 (0.0)	1 (1.8)	54 (98.2)	55 (100)
Total	**2 (0.2)**	**(16) 1.3**	**1232 (98.5)**	**1250 (100)**

The Apgar score at 5 minutes revealed that the vast majority of neonates required no further resuscitation since 98.6% of neonates had an Apgar score of 8-10. The group with the lowest proportion of neonates was the LOP position (96.4%) and the groups with the highest were the ROA and DOA groups at 100%.

Only 1.3% of neonates had an Apgar score of 4-7 at 5 minutes, with the LOP position having the highest proportion of neonates at 3%. All the remaining positions had a 0-2% range of neonates with an Apgar score of 4-7 at five minutes.

Only 2 neonates had an Apgar score of 0-3 at 5 minutes, that was in the LOL and the LOP group. To further explore any association the Apgar score at 5 minutes was analysed against cavity grouped fetal positions.

Table 5.29. Apgar score at 5 minutes with cavity grouped fetal position

Apgar score at 5 minutes

Fetal occiput position	**Apgar score 0-3 n (%)**	**Apgar score 4-7 n (%)**	**Apgar score 8-10 n (%)**	**Total**
OA	0 (0.0)	1 (0.3)	296 (99.7)	297 (100)
OL	1 (0.2)	6 (1.0)	575 (98.8)	582 (100)
OP	1 (0.3)	9 (2.4)	361 (97.3)	371 (100)
Total	**2 (0.2)**	**16 (1.3)**	**1232 (98.7)**	**1250 (100)**

Table 5.29 showed that overall the percentage variation between the grouped cavity positions was not very large amongst the three Apgar groups and the differences were not statistically significant (p=0.13).

CHAPTER 6

DISCUSSION

6.1. Main Results

The aim of this prospective study was to establish the association between fetal position at the onset of labour, and birth outcomes in particular mode of delivery for the mother and the neonate. Specifically it was the LOA position which based on Sutton's theory hypothesised as being linked to improved outcomes that was explored.

The data from the study demonstrated that the LOA position at the onset of labour was not associated with mode of delivery which was the primary outcome measure. None of the eight positions identified at the point of labour onset were associated with mode of delivery.

The secondary outcome measures of pain relief, duration of labour, augmentation, and Apgar scores, did not reveal any association with fetal position, with the exception of pain relief. Of the eight forms of pain relief available, the proportion of women using pethidine to those who did not across the 8 fetal positions was statistically significant. Further categorisation into cavity grouped positions of anterior, lateral and posterior groups showed that the posterior group was more likely to use pethidine compared to the other groups.

The study also provided data on prevalence of fetal occiput position at the point of labour onset (Table 5.5 – Occiput Prevalence), such data not having been published before, nor reported in any Midwifery or Obstetric textbook. The study data demonstrated that of the cavity grouped fetal positions the anterior group at the onset of labour was the least frequently occurring at 23.7%. Specifically the ROA position was the least occurring position amongst all 8 fetal positions. The posterior positions occurred amongst 29.7% of the women, which is two to three times the reported figures of OP presentations at the onset of labour (Gardberg et al., 1998, Gardberg and Tuppurainen, 1994, Fitzpatrick et al., 2001, Sizer and Nirmal, 2000, Neri et al., 1995, Faber, 1998). The lateral positions were the most commonly occurring fetal occiput position with 46.5% of the women in the study shown to have this position. The most prevalent of the 8 fetal occiput positions was the LOL position.

The prevalence of fetal spine position reflected similar patterns to that observed for the occiput groups, with the lateral groups most prevalent, specifically the LspL position (Table 5.6 – Spine Prevalence). The only difference observed between the distribution of the occiput and spine position was that the cavity grouped anterior spine position was the second most common group with the posterior group being least common, the reversal of what was observed in the occiput group. The importance of the prevalence of fetal spine position was that no figures to date have been published on prevalence of spine position, thus data from the study provided additional new knowledge.. Furthermore, the prevalence of the combined fetal occiput and spine position, referred to as combination grouping has also never been matched or reported.

The results of the combination grouping showed that there were common groups; uncommon groups are several combination groups that were incompatible. The analysis of data on fetal position revealed that in the majority of cases the occiput and the spine share corresponding identical positions, and that the most common position for the fetus to adopt at the onset of labour in nulliparous women at term gestation was the LOL&LspL position.

6.2. Strengths and Weaknesses of Study

The rigorous planning and piloting of the study aimed to minimise weaknesses and enhance scientific strengths. During the planning of the study the use of a prospective design was deemed mandatory if the associative relationship between fetal position and labour outcomes was to provide best available evidence. The ability to determine the eligibility criteria minimised confounding variables that would otherwise generate arguments relating to validity. The prospective approach allowed controls to be imposed in order to standardise processes of assessment of fetal position. Once such controls were applied it allowed study participants to be followed until the outcome of delivery was observed and recorded. The primary outcome measure of mode of delivery was an objective measure and did not give rise to issues of subjectivity. Moreover it was routinely collected so not influenced at all by study purposes. The ability to design a study and impose controls increased the validity of the study and eliminated potential bias, particularly relating to possible confounding variables that may otherwise result in competing explanations.

Since the point of measure during which fetal position was to be determined was paramount, the definition of early labour as outlined by the National Institute of Clinical Excellence was used and is the one also used in the centre in which the study was undertaken (See section 3.5 - Definition of Labour Onset and Period of Measure) (NICE, 2007). The use of the definition clearly identified the point commencing and ending early labour, outlining the period during which measure of fetal position was to be undertaken. To control the point of interest further a rule of 12 hour repeat measure was applied so if the mother did not enter established labour within 12 hours of the fetal position being identified the measure would be repeated.

The use of a 'gold standard' technique of ultrasound to measure fetal position further enhanced the validity of this independent variable, ensuring that misclassification caused by subjective measures ware decreased. The midwives trained to perform the ultrasound were taught by the same sonographers and underwent an identical assessment including completion of a training log of 40 individual cases. The successful implementation of the study also showed that the use of ultrasound to accurately detect fetal position at the onset of labour was feasible and acceptable to women during early labour.

Internal validity was further enhanced as the scans performed were validated by an independent clerk. The clerk observed the scan pictures against the diagrams outlined by the scanning midwife to determine agreement and define position. The diagram that was used by the scanning midwife was not labelled with the individual positions; instead the scanning midwife was asked to simply replicate the position defining structure as observed on ultrasound and not to define position which was done independently by the clerk. The routine procedures applied ensured constancy of condition which intern highlighted the validity achieved. Random checks were also performed where two trained scanning midwives would freeze the position defining structure on the ultrasound machine and replicate the structure independently. This was then sealed and sent to the independent clerk for agreement. Further contingencies included blinding of the scan findings to the attending clinician and the woman being scanned so that such information would not influence the care received or behaviour and expectations of the woman/clinician.

To maximise representativeness and generalisability, all areas that women would attend throughout their pregnancy were involved with the recruitment process. The primary recruiters were the community midwives who recruited from a specific clinic that all women were required to attend. This not only ensured a high recruitment rate but also that the sample population was similar to that at the recruiting hospital. The extensive recruitment process meant that no one particular group of women were targeted but instead the entire population had the opportunity to take part in the study.

Similarities were therefore observed with ethnic diversity and mode of delivery between the BWH eligible population and that represented in the sample population (Refer to tables 5.1 & 5.3). The largest ethnic group in both the sample population and the total population was the White-British group at 56.0% and 58.0%. The next largest was the Pakistani group which constituted 18.0% of the sample and 15% of the total population and the third largest was the Indian group, forming 6.3% of the sample and 6.5% of the total population. The remaining smaller groups also showed similarities.

Mode of delivery rates also showed consistency between sample and total hospital population, with the SVD rate being 53% in the sample and 57% at the BWH. The small discrepancy is likely to be due to the study inclusion criteria. The documented delivery figures available for nulliparous women at BWHCT did not distinguish between gestation, multiple pregnancy, fetal abnormality, breech vaginal deliveries and other characteristics that were excluded from the study. It is therefore possible that this small discrepancy may account for women whom would otherwise due to fetal abnormality, multiple pregnancy and breech presentation be excluded from the study.

Ventouse deliveries accounted for 14% of the deliveries in the sample compared to 12% at BWHCT. Forceps deliveries, inclusive of all types, accounted for 12% of the total deliveries in the sample compared to 10% reported at BWH. The CS rate was 20% in the sample, the same as the rate at the BWH. Therefore the observed mode of delivery rates appear to show good representativeness in this sample.

The calculation of sample size was extremely important if the pre-determined effect size was to be detected reliably. The limited data on SVD rates for the LOA position meant that figures on OP position were used instead. The sample size allowed an absolute difference of 15% in SVD rates to be detected between groups with a power of 89%. This required a sample size of 1250 women which was achieved within a period of 18 months thus ensuring an adequate recruitment rate of the total population.

Of the 1250 women recruited and scanned to the study 100% of the outcome data was obtained for every study participant including both the primary and secondary outcome measures required to undertake complete analysis.

Logistic regression analysis was undertaken to explore both the strength and pattern of association, between SVD rates and fetal occiput position, and to adjust for variables that were known to be associated with SVD. The variables were maternal age, epidural analgesia, labour duration and neonatal birth weight. Despite the multiple logistic regression finding demonstrating no significant associations for fetal position, all four above variables confirmed known trends of association, therefore increasing confidence in the study data and thus study findings.

The main limitation of the study, which was evident retrospectively, was the inability to obtain data on fetal position during the second stage of labour and at delivery. The main aim of the study was to determine fetal position at the onset of labour and examine the association with birth outcomes. Since the study revealed that fetal position at the onset of labour was not associated with mode of delivery, the availability of data on position during second stage may have provided further explanatory information. If data on position during second stage was obtained analysis into mal-rotation may have been determined, since there remains a debate as to whether the persistent OP, which is associated with increased morbidity, is as a result of mal-rotation or the persistence of an initial OP position. Data on position at second stage may have provided the answer to this question, and clarified the overall issue.

The hospital computer system was reviewed to determine whether routine data on fetal position at delivery was available, but fetal position at delivery was entered as:

- Spontaneous anterior
- Spontaneous other
- Ventouse
- Forceps
- Breech
- Emergency CS
- Elective

The above categorisation did not provide adequate information to undertake the analysis.

Another limitation was that it was not possible to identify from the hospital medical systems women who arrived at the hospital in active labour therefore not eligible, thus an exact calculation of recruitment rate was not possible. Of the 2035 women who were eligible, 1647 were recruited and scanned with a total of 388 potential women lost. The recruitment rate was therefore recorded as a range of a minimum of 61.4% to a maximum of 75.9% if presumed that either all or none of the 388 women lost were actually ineligible (Refer to figure 5.1 – Recruitment of study sample).

6.3. Interpretation of Findings

The main initiative for this study was to contribute scientific knowledge to the increasing move towards promoting a single fetal position (LOA) as optimum. Such a move was led by a midwife, Jean Sutton who used anecdotal evidence from a life time of experience to support her claims. At a time where all practice should be supported by scientific evidence, the continuation of such practice with the absence of scientific evidence was undesirable. The fetal position described as optimum was the LOA position, that Sutton (2001) claimed would facilitate anterior rotation preventing mal-rotation and consequently resulting in a:

- shorter labour duration
- less need for pain relief
- less intervention
- increased rate of SVD

Findings from this study revealed no association between the LOA position or the LspA position and mode of delivery. Instead the LOA position showed to have a slightly lower rate of SVD compared to all non-LOA positions although this was not statistically significant. Furthermore, the LOA position was not associated with either a reduction in need for pain relief, labour duration or use of intervention. The only association was between the use of pethidine analgesia and cavity grouped posterior fetal positions. Individual position analysis of pethidine use did not reveal any significant results, suggesting that the association was connected to grouped posterior cavity positions only.

The relationship between increasing use of pain relief and the posterior fetal position in active labour is well documented (Simpkin, 2010, Fitzpatrick et al., 2001, Gardberg et al., 1998, Ponkey et al., 2003). One argument as to why the link between OP at labour onset and pethidine use was also evident may be related to the physiological principles of OP engagement. The increased diameter entering the pelvic brim in early labour may only be achieved with increased uterine activity consequently requiring further pain relief. Additionally it may be linked to the perception of OP labours being longer and associated with morbidity, thus influencing women and professionals to the increase use, if position is thought to be OP. Other forms of pain relief did not reveal a similar association, which may be because further pain relief is only available in active labour.

Sutton's theory that the LOA fetal position is the optimum position for the fetus to adopt at the onset of labour was not supported by the findings of this study thus confirming that antenatal practices to encourage an LOA fetus should not be promoted.

In addition, the study did not confirm known associations of fetal position, mainly OP mal-position with increased operative delivery, oxytocin augmentation, labour duration and low Apgar scores (Ponkey et al., 2003, Fitzpatrick et al., 2001, Cheng et al., 2006). The most likely reason for this is that the studies were undertaken with position measured during the active first or second stage of labour, therefore investigating the persistent occiput posterior position comparative to grouped anterior and/or lateral positions, where as the present study measured position at labour onset prior to the commencement of active labour. The main comparison was undertaken against 'all' individual fetal positions at 'labour onset' and not solely grouped positions. The dissimilar results are therefore not a consequence of contradictory findings but are new findings that have not previously been reported.

The lack of association between fetal position at labour onset and delivery outcomes suggests that no cause/effect relationship exists between the variables. To speculate on the reason for such, is that the onset of labour mainly involves fetal manoeuvres of engagement, descent and flexion which are manoeuvres which are less likely to deviate. The manoeuvres required during active labour however are that of rotation, extension and external rotation which due to the increased nature of movement required are more likely to deviate.

The specific delivery modes of CS, ventouse and forceps deliveries did not show any association with any of the fetal occiput positions. In the analysis of spine position the RspL position showed a significant association suggesting a 20% lower rate of SVD compared to all other position groups (p=0.02). Nonetheless, the identification of a single result as significant following a large number of non-significant results is not considered of huge importance mainly because it is probably a consequence of a chance finding rather than a true significant result (Bland and Altman, 1995). The rates of SVD amongst the overall cavity grouped fetal positions of anterior, lateral and posterior positions were very similar.

Some of the findings reported by this study are supported by Gardberg et al.'s (1998) findings, who reported no association between fetal position and mode of delivery, epidural use, and duration of first or second stage of labour. Gardberg et al.'s (1998) study however only investigated grouped posterior and anterior positions and despite claiming that fetal position was recorded at labour onset this was not defined. Gardberg et al.'s (1998) study had many flaws, however the results in part support those reported by this study.

Results on prevalence of fetal position also revealed notable findings, primarily rates of cavity grouped fetal position. The lateral positions were the most prevalent position, specifically the most frequently occurring position was the LOL position (27.4%). Although fetal position had not been explored at this point of early labour before, there are a few studies that have published figures on cavity grouped fetal positions (anterior, lateral & posterior) during active labour. These are shown in Table 6.1 and indicates some similarities to the data on occiput prevalence in this study.

Table 6.1. Study results on prevalence of grouped fetal position and point of measure.

			Prevalence of occiput position		
Study	**Classification of labour stage**	**Sample size**	**Anterior % (95% CI)**	**Lateral % (95% CI)**	**Posterior % (95% CI)**
Study results (England)	**Early labour**	1250	23.8 (21.4,26.2)	46.5 (43.7,49.3)	29.7 (27.2,32.2)
(Blasi et al., 2010) (Italy)	**Active**	100	28.4 (19.6,37.2)	20.3 (12.4,28.2)	51.4 (41.6,61.2)
(Akmal et al., 2004a) (England)	**Active**	601	27.6 (24.0,31.2)	37.6 (33.7,41.5)	34.8 (31.0,38.6)
(Akmal et al., 2004c) (England)	**Active**	432	29.4 (25.1,33.7)	37.6 (33.0,42.2)	33.6 (29.1,38.1)
(Akmal et al., 2002) (England)	**Active**	496	31.0 (26.9,35.1)	37.4 (33.2,41.7)	31.4 (27.3,35.5)

Despite all these studies having a different point at which position was diagnosed, excluding that of Blasi et al.'s (2010) which yielded unexpected figures that remain unexplained, the remaining 3 studies report similar data on prevalence to this study. In all the studies the lateral group was the most prevalent which was expected in accordance with labour mechanism, with the fetus commencing labour in the transverse plane ready to descend into the maternal pelvis (Caruthers, 2000, Cunningham et al., 2008, McCormick, 2008).

The posterior group was the next most prevalent, and the anterior positions were least prevalent, a pattern of distribution synonymous across all three studies (Akmal et al., 2004a, Akmal et al., 2004c, Akmal et al., 2002). The small variations amongst the individual rates of lateral, posterior and anterior prevalence may be due to the stage at which position was identified, and reflect fetal position prior and post rotational descent.

Studies have reported figures on the prevalence of the posterior fetal position to be 10-15% in 'early labour', such claims are not supported by this study (Sizer and Nirmal, 2000, Gardberg et al., 1998, Gardberg and Tuppurainen, 1994, Fitzpatrick et al., 2001, Neri et al., 1995). The discrepancy in the figures on posterior fetal position is difficult to explain since determining whether posterior positions are increasing as some claim, or, if it is as a consequence of studies using ultrasound to report accurate figures is difficult to distinguish (Sutton, 2007).

What remains intriguing about the findings on grouped positions and labour process, is that review of textbooks suggests that occiput engagement takes place in the transverse/lateral position (Cunningham et al., 2008, Dietze, 2001, McCormick, 2008, Selman and Johnston, 2010). No textbook describes the mechanism of labour when a position other than a lateral position is identified at the onset of labour, that is, despite this study identifying that over half of the fetal positions engaged in a position other than the transverse position (53.5% - Table 5.5 Frequency of fetal occiput position). The majority of textbooks outline that complete fetal engagement in the posterior position prior to the onset of labour is unusual. The understanding is that the majority of posterior fetuses will remain unengaged until uterine contractions and membrane rupture urge engagement and descent (Coates, 2002, Coates, 2008). This study revealed that 29.7% of fetuses were posterior and entered established labour within 12 hours thus suggesting some degree of engagement at the pelvic brim was achieved, yet mechanism of labour pertaining to the posterior position remains unreported.

Furthermore, it is thought that the direct positions (DOA & DOP) are only adopted during the final labour stage prior to the expulsive phase (Dietze, 2001, Selman and Johnston, 2010, McCormick, 2008). Yet again mechanism with a fetus in the direct position is not reported in any literature, yet this study identified that 12% of fetuses were in either of the direct positions. Such findings are atypical since literature that reports pelvic measures state that the anterior-posterior plane of the pelvic brim is 11cm, where as a fetus engaging in the direct position must descent with its widest diameter reported to be 11.5cm, suggesting that such is not possible (McCormick, 2008, Cunningham et al., 2008). In this study however, not only were 12% of fetuses observed in a direct position but the DOA position also had the highest SVD rate at 59.0%, although contrary to that, the DOP position had the lowest rate of SVD at 47.3%. This discrepancy is however understandable as the DOA fetus is able to achieve complete flexion whilst the DOP fetus must descent in a deflexed manner as the maternal spine prevents flexion (refer section 1.2- Fetal Mal-position).

This study has not answered the questions relating to labour mechanism and nor did it aim to do so, nonetheless it has urged the discussion of labour mechanism and has challenged current understanding of a process that remains partially explored.

This study is the first to report on the proportion of individual fetal positions at the onset of labour, showing that the LOL position was most prevalent followed by the ROL position. Only two other studies published figures on the prevalence of all 8 fetal positions, but both report data from the active stage of labour rather than early labour. These findings are shown in Table 6.2.

Table 6.2. Study results on prevalence of individual occiput positions.

	Prevalence of occiput position % (95% CI)							
Study	**LOA**	**ROA**	**DOA**	**LOL**	**ROL**	**LOP**	**ROP**	**DOP**
Study Results	12.4 (10.6,14.2)	3.8 (2.7,4.9)	7.6 (6.1,9.1)	27.4 (24.9,29.9)	19.1 (16.9,21.3)	13.4 (11.5,15.3)	11.9 (10.1,13.7)	4.4 (3.3,5.5)
Souka et al., 2003	22.0 (15.3,28.7)	18.0 (11.8,24.2)	1.5 (0.00*,3.5)	15.0 (9.2,20.8)	4.4 (1.1,7.7)	20.0 (13.6,26.4)	13.9 (8.3,19.5)	4.4 (1.1,7.1)
Akmal et al., 2002	21.0 (17.4,24.6)	3.0 (1.5,4.5)	7.0 (4.8,9.2)	26.0 (22.1,30.0)	11.4 (8.6,14.2)	11.4 (8.6,14.2)	18.0 (14.6,21.4)	2.0 (0.8,3.2)

*= Negative value rounded to zero

These figures show a visible variation from those found in this study. Souka et al.'s (2003) found that the LOA position was the most prevalent, in contrast to the findings of this study. Akmal et al.'s (2002) findings were similar in part to those reported by Souka et al. (2003) and those reported by the study. Like the study findings a lateral position – LOL, was the most prevalent position followed by the LOA position. The least prevalent position was the DOP and ROA position with a 1% difference between the two positions, these findings were similar to that of the study findings. What is consistent between all three studies is that left positions overall appear to be more common than the right positions, the figures are presented in Table 6.3.

Table 6.3. Study results on prevalence of cavity grouped left and right fetal positions

Prevalence of occiput position % (95% CI)

(Left = LOA+LOP+LOL, Right = ROA+ROP+ROL)

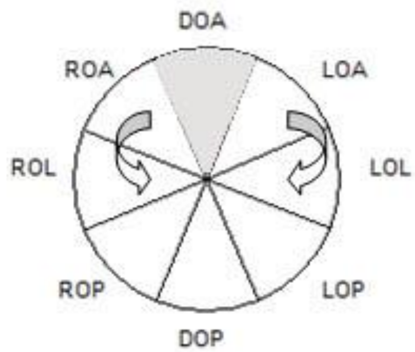
Study	Left	Right
Present Study	53.2 (50.4,56.0)	34.8 (32.2,37.4)
Souka et al. (2003)	57 (49.0,65.0)	36.3 (28.6,44.0)
Akmal et al. (2002)	58.4 (54.1,62.7)	32.4 (28.3,36.5)

It is clear that left positions as a whole are more prevalent than the right positions and despite studies showing variations in individual occiput position distribution, when observed in grouped occupancy of left or right region similarities are markedly obvious (Table 6.3).

The recording of fetal occiput and spine position has meant that for the first time combination grouping was undertaken. The devised method of combination grouping allowed both the occiput and spine to be matched and reported. As outlined, certain combinations of occiput and spine were observed and certain combinations were evidently incompatible.

The study revealed that the fetal head could only rotate to a certain point before anatomy would restrict further movement therefore disallowing certain spine and occiput combinations. From the results it was apparent that the majority of combination positions could rotate up to 90° either side from the neutral or any constant position of occiput or spine. Nonetheless, in almost all the combination groups with the spine constant the occiput actually rotated up to 135° in either direction from its neutral or constant position. Fig 6.1 shows an example using the spine in the DOA/DspA position (seen as the shaded segment) and the possible position sections the occiput could rotate up to in either direction. What was noted was that the further the occiput rotated from a constant spine position the less likely that occiput/spine position combination occurred.

Figure 6.1. Degree of occiput rotation (!).



(!) With the spine constant at DOA position the arrows demonstrate the degree of occiput rotation.

In the majority of cases the occiput was not seen to extent greater than 135° in either direction. What this suggests is that the occiput can rotate 2 positions away from the constant spine position in either direction. Although we would understand that further rotation greater than 135° was not possible, it was noted in a select few cases. In 11 cases the occiput rotated greater than 135°, the maximum rotation seen was 180°. The 11 cases that were noted did not show any dissimilar characteristics that may suggest a reason as to why these few cases were able to rotate to such an extent. No case of greater rotation extending 180° was noted; therefore it is assumed that anatomically greater rotation is not physically possible. The data also revealed that in the majority of cases the fetal spine position corresponds with the fetal occiput position. A Kappa test gave a statistic of 0.68 suggesting 'substantial agreement' with occiput and spine combination.

Such data may influence clinical practice which utilises the fetal occiput to determine fetal position. The advantage of position alignment could ease the discomfort and risk of infection associated with deep pelvic and vaginal examination used to assess fetal position. If position could be determined by abdominal palpation alone by using spine position and assuming alignment of the occiput, this would reduce the need to perform deep pelvic palpation or/and vaginal examination. The study has shown that the identification of the fetal spine would at least demonstrate that the occiput would be either aligned or two positions either side. This however requires extensive exploration as a method of accurately identifying fetal position particularly in light of Webb's (2009) findings.

This APOLLO study as a whole addressed two inter-linked questions, firstly the association of fetal position and birth outcomes and secondly the accuracy of abdominal palpation to assess the LOA position. Webb (2009) undertook analysis of the second aim, pertaining to abdominal palpation, where she used the findings of position on ultrasound as a reference standard and compared this against the findings of abdominal palpation by midwife clinicians. Webb (2009) reported sensitivity and specificity to detect the LOA position on abdominal palpation. She found that of the 61 LOA positions identified on ultrasound, only 21 were correctly identified demonstrating 34% (95% CI 24,47) sensitivity and 78% (95% CI 67,75) specificity. The conclusion overall was that abdominal palpation as a means to correctly identify the LOA fetal occiput position was poor. Although Webb (2009) aimed primarily to address the accurate assessment of the LOA position, she also reported that in total only 16% of all fetal positions were identified accurately by abdominal palpation. Such findings are concerning, particularly in relation to the validity of a routine assessment tool, and would have created greater concerns if a position was identified as optimum.

The findings of both aspects of the overall APOLLO study have confirmed that scientific evidence is essential before any practice is adopted as routine into mainstream Midwifery or Obstetrics.

6.4. Implication for Practice

The concerns associated with increasing rates of intervention namely operative delivery has encouraged management options to be explored as a way of addressing such issues. The theory of OFP was one such approach, however the evidence from this study has demonstrated that such an approach is not associated with beneficial maternal or neonatal outcomes and consequently should not be promoted.

The availability of information is vital if women are to make an informed choice, and therefore information pertaining to alternative approaches should be made available by maternity associated organisation. It is however the promotion of a theory such as OFP as a means of reducing intervention and operative delivery that is not supported this study that must be conveyed accordingly.

The apparent implications for practice are evident, however the findings of the research extend further to associated areas of every day practice. Principally the area of early labour and latent phase, where examination to determine fetal position is recommended in both midwifery textbooks and by NICE in the published intrapartum guidelines (Coad and Dunstall, 2005, McCormick, 2009, NICE, 2007). It is questionable as to why the additional discomfort associated with clinical procedures to determine fetal position are required at all during the point of labour onset. Additionally the results to the other part of the overall study provide an additional argument to the practice and ethical implications of a procedure that has a low rate of accuracy and the findings of which are shown not to be associated with outcome (Webb, 2009). Such practices however require further discussion and debate alongside current evidence to determine the best way forward.

In view of the inaccuracy in determining fetal position subsequent studies would require use of ultrasound to ensure fetal position is determined accurately.

6.5. Generalisability

BWHCT is the largest provider of maternity services in Birmingham and a tertiary referral centre consequently serving a diverse population. Birmingham is also the second largest city in the UK, and is known for its ethnic diversity. The main reason for conducting the study at BWHCT was to achieve the diverse mix within the sample population. As outlined in section 5.2 the sample population was representative of the overall population in terms of mode of delivery and ethnic diversity. The recruitment rate of 61.4%-75.9% supports the claims of sample representativeness and thus the ability to generalise the findings to the target population. The sample population was also representative of the Birmingham population and the ethnic mix observed nationally as outlined by the National Consensus, with the largest group being white, followed by the Pakistani, Indian and then the Black African/Caribbean groups (DOH, 2001). This is the same pattern of majority groups observed at BWHCT and in the sample for the study. Although the proportions amongst each group vary this was expected as national statistics on ethnic diversity report collective figures on all ages, gender and area of residence. The generalisability therefore of the study findings would be suited to at least the childbearing population of the Birmingham district.

The study was designed so that it could be reproduced in the majority of clinical settings where access to ultrasound and trained sonographers were available. The point at which ultrasound is to be performed is routinely assessed by midwives upon admission to most labour wards, so no additional services would be required. The technique used to determine fetal position on ultrasound is well published and understood as the 'gold standard' method of determining fetal position (Akmal et al., 2003, Chou et al., 2004, Zahalka et al., 2005).

Finally the sample representativeness, the power of 89% obtained from the sample size, the recruitment rate of 61.4%-75.9% and the detail applied to the implementation of the study increased the generalisability of the study findings.

It is argued that at a time when all practice should be research based, promoting a single position as optimum must be confirmed as beneficial before such practices become routine. The study has shown that the LOA fetal position is not associated with improved outcomes and therefore such findings should be generalised to the wider population.

6.6. Recommendations for Further Research

The study has answered the question initially posed; however it has also highlighted a dearth of knowledge with regards to mechanism of labour, and bought to question the validity of basic beliefs of the labour and delivery process. Consequently this has established that further exploration is paramount. The areas that require further research include:

- **Mechanism of labour**: In all the textbooks that were reviewed the labour process is described with the fetus engaging in the transverse position. This study has shown that not all fetuses engage in this position but instead over half engage in the anterior, posterior or the direct positions. The mechanism involved when a fetus commences labour in a position other than the lateral position has never been documented, suggesting that mechanism remains undetermined. Further research is required into labour mechanism when fetuses adopt positions other then the lateral position for engagement.
- **Fetal position (active labour):** This study explored the association of 'all' fetal positions at the onset of labour, yet no study to date has reviewed 'all' fetal positions in active labour and determined the association with birth outcomes. The investigation of all positions in active labour may identify yet a position that is optimum.
- **Fetal position (second stage):** Since the process of labour involves rotational decent, the identification of all fetal positions at labour onset and follow-up during second stage would determine if fetal position at labour onset influenced the direction of

rotation. This is particularly important since mal-position is associated with increased morbidity for the mother and the newborn.

- **Abdominal palpation:** The use of the occiput to determine fetal position was found to be poor, this study has shown that the fetal spine corresponds with the fetal occiput in the majority of cases. More research is required into new or adapted techniques and training that may enhance the clinical skills of palpation.

CONCLUSION

The position of the fetus during and throughout labour exerts considerable influence on the process of active labour and delivery, with mal-position known to contribute towards maternal and neonatal morbidity. The morbidity associated with mal-position and the belief that this is contributing towards the increasing rates of operative delivery has led to the implementation of theories such as OFP. OFP advocates the promotion of a single position that being the LOA position as optimum in achieving spontaneous vaginal delivery comparative to all other fetal positions. The lack of scientific evidence resulted in much criticism of a theory that was otherwise attempting to salvage the normal birth process.

This prospective study aimed to establish the association between fetal position at the onset of labour and birth outcomes for the mother and her newborn. In particular the optimum characteristics of the LOA position in achieving SVD were explored in order that Sutton's theory could be supported or refuted. It demonstrated that the LOA position was not associated with increased rates of SVD or other improved outcomes, therefore negating Sutton's claim of an optimal fetal position. None of the fetal positions were associated with mode of delivery or improved birth outcomes.

The unease associated with the increasing rates of intervention and operative delivery is of concern to all those involved with maternity care. Despite such concerns unsupported theories should not be applied as a way in solving the complicated issues of childbirth.

Instead, ideas must be tested through rigorous scientific measure before any theory is applied to routine practice as a way forward.

Appendix 1

Search Result of Systematic Review

HEALTHCARE DATABASES ADVANCED SEARCH

Search History

SAVE SELECTED ROWS SAVE ALL

Show Last 10

No.	☐	Database	Search term	Hits
1	☐	EMBASE, MEDLINE, CINAHL	(mode AND of AND delivery).ti,ab	12787
2	☐	EMBASE, MEDLINE, CINAHL	(delivery AND mode).ti,ab	12787
3	☐	EMBASE, MEDLINE, CINAHL	birth.ti,ab	355383
4	☐	EMBASE, MEDLINE, CINAHL	SVD.ti,ab	1777
5	☐	EMBASE, MEDLINE, CINAHL	(spontaneous AND vaginal AND delivery).ti,ab	3574
6	☐	EMBASE, MEDLINE, CINAHL	(vaginal AND delivery).ti,ab	23329
7	☐	EMBASE, MEDLINE, CINAHL	(spontaneous AND delivery).ti,ab	14054
8	☐	EMBASE, MEDLINE, CINAHL	(normal AND delivery).ti,ab	40544
9	☐	EMBASE, MEDLINE, CINAHL	(normal AND birth).ti,ab	47012
10	☐	EMBASE, MEDLINE, CINAHL	1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9	418971
11	☐	EMBASE, MEDLINE, CINAHL	(foetal AND position).ti,ab	338
12	☐	EMBASE, MEDLINE, CINAHL	(foetal AND presentation).ti,ab	411
13	☐	EMBASE, MEDLINE, CINAHL	(foetal AND spine AND position).ti,ab	4
14	☐	EMBASE, MEDLINE, CINAHL	(foetal AND malposition).ti,ab	22
15	☐	EMBASE, MEDLINE, CINAHL	(foetal AND occiput).ti,ab	6
16	☐	EMBASE, MEDLINE, CINAHL	(foetus AND position).ti,ab	194
17	☐	EMBASE, MEDLINE, CINAHL	(foetus AND presentation).ti,ab	215
18	☐	EMBASE, MEDLINE, CINAHL	(foetus AND occiput AND position).ti,ab	2

Appendix 1 – Results of Systematic Review

19	☐	EMBASE, MEDLINE, CINAHL	(foetus AND occiput).ti,ab	8
20	☐	EMBASE, MEDLINE, CINAHL	(foetus AND spine AND position).ti,ab	5
21	☐	EMBASE, MEDLINE, CINAHL	(foetus AND spine).ti,ab	29
22	☐	EMBASE, MEDLINE, CINAHL	(foetus AND malposition).ti,ab	9
23	☐	EMBASE, MEDLINE, CINAHL	(foetal AND spine).ti,ab	52
24	☐	EMBASE, MEDLINE, CINAHL	(fetal AND position).ti,ab	4716
25	☐	EMBASE, MEDLINE, CINAHL	(fetal AND presentation).ti,ab	5180
26	☐	EMBASE, MEDLINE, CINAHL	(fetal AND occiput AND position).ti,ab	167
27	☐	EMBASE, MEDLINE, CINAHL	(fetal AND occiput).ti,ab	271
28	☐	EMBASE, MEDLINE, CINAHL	(fetal AND spine).ti,ab	884
29	☐	EMBASE, MEDLINE, CINAHL	(fetal AND spine AND position).ti,ab	100
30	☐	EMBASE, MEDLINE, CINAHL	(fetal AND malposition).ti,ab	174
31	☐	EMBASE, MEDLINE, CINAHL	(fetus AND position).ti,ab	1666
32	☐	EMBASE, MEDLINE, CINAHL	(fetus AND presentation).ti,ab	2005
33	☐	EMBASE, MEDLINE, CINAHL	(fetus AND occiput AND position).ti,ab	59
34	☐	EMBASE, MEDLINE, CINAHL	(fetus AND occiput).ti,ab	111
35	☐	EMBASE, MEDLINE, CINAHL	(fetus AND spine).ti,ab	360
36	☐	EMBASE, MEDLINE, CINAHL	(fetus AND spine AND position).ti,ab	40
37	☐	EMBASE, MEDLINE, CINAHL	(fetus AND malposition).ti,ab	75
38	☐	EMBASE, MEDLINE, CINAHL	(fetus AND malpresentation).ti,ab	57
39	☐	EMBASE, MEDLINE, CINAHL	(fetal AND malpresentation).ti,ab	302
40	☐	EMBASE, MEDLINE, CINAHL	(foetus AND malpresentation).ti,ab	7

Appendix 1 – Results of Systematic Review

41	☐	EMBASE, MEDLINE, CINAHL	(foetal AND malpresentation).ti,ab	37
42	☐	EMBASE, MEDLINE, CINAHL	11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23 OR 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31 OR 32 OR 33 OR 34 OR 35 OR 36 OR 37 OR 38 OR 39 OR 40 OR 41	13678
43	☐	EMBASE, MEDLINE, CINAHL	(onset AND of AND labour).ti,ab	2645
44	☐	EMBASE, MEDLINE, CINAHL	(onset AND of AND labor).ti,ab	4747
45	☐	EMBASE, MEDLINE, CINAHL	(latent AND phase).ti,ab	4131
46	☐	EMBASE, MEDLINE, CINAHL	(latent AND phase AND of AND labour).ti,ab	123
47	☐	EMBASE, MEDLINE, CINAHL	(latent AND phase AND of AND labor).ti,ab	284
48	☐	EMBASE, MEDLINE, CINAHL	(early AND labour).ti,ab	3747
49	☐	EMBASE, MEDLINE, CINAHL	(early AND labor).ti,ab	6636
50	☐	EMBASE, MEDLINE, CINAHL	(labour AND onset).ti,ab	2645
51	☐	EMBASE, MEDLINE, CINAHL	(labor AND onset).ti,ab	4747
52	☐	EMBASE, MEDLINE, CINAHL	43 OR 44 OR 45 OR 46 OR 47 OR 48 OR 49 OR 50 OR 51	20213
53	☐	EMBASE, MEDLINE, CINAHL	42 AND 52	571
54	☐	EMBASE, MEDLINE, CINAHL	10 AND 53	398
55	☐	EMBASE, MEDLINE, CINAHL	42 AND 52	
56	☐	EMBASE, MEDLINE, CINAHL	10 AND 55	
57	☐	EMBASE, MEDLINE, CINAHL	42 AND 52	
58	☐	EMBASE, MEDLINE, CINAHL	1 OR 2 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9	
59	☐	EMBASE, MEDLINE, CINAHL	57 AND 58	
60	☐	EMBASE, MEDLINE, CINAHL	10 AND 42 AND 52	

Appendix 2

Information Leaflet for Midwives

THE APOLLO STUDY
Analysis of Fetal **P**osition at the **O**nset of **L**abour and **L**abour **O**utcomes

1. Introduction to the research project

The APOLLO Study is a midwifery study examining the relationship between specific fetal cephalic positions at the onset of labour and labour and birth outcomes in nulliparous women. This study is a preliminary project needing to be done in order to establish an evidence base to underpin theories promoting maternal posturing to encourage the fetus to lie in a supposed optimal position.

2. What is the purpose of the study?

We believe that the exact position a baby is lying in when it lies head down at the beginning of labour influences how labour progresses and how the baby is born. We hope this study will provide the information needed to determine if this is true.

We are inviting as many women expecting a straightforward birth with their first baby as we can to join the study. We are aiming for 1250 women in total to be involved in the study and anticipate that it will take 12-18 months to complete the study.

3. What will happen to the women who take part in the study?

There is nothing special that they have to do. Their agreement to participate in the study will give permission for a research midwife to perform an additional abdominal palpation to determine fetal lie, presentation and position when they attend hospital in early labour or if labour is being induced. The research midwife will also confirm her abdominal palpation by performing an ultrasound scan.

4. What will I have to do?

We need you to recruit as many nulliparous women as you can to the study from 28 gestational weeks. Eligible women are nulliparous women with a singleton pregnancy and where the baby is not expected to have an abnormality.

We need you to explain the study to eligible women and gain their informed consent to join the study. This will involve you getting the consent form signed, placing it in the notes and marking the front of the green hand-held notes with a sticker so that it is visible.

You will need to give the women the information leaflet explaining what the study involves and who to contact if they have more questions, and also give them a copy of the signed consent form

5. What are the risks?

Abdominal examination is not an invasive procedure and ultrasound is safe. The APOLLO Study involves an additional abdominal examination to determine specific fetal cephalic position with confirming ultrasound carried out by the midwife researcher at the beginning of labour.

6. What are the benefits?

Eventually we hope to collect enough information about enough women and babies to see if there is any particular position that benefits labour progress and how the baby is born. If this is shown, then we hope to be able to inform women how to promote this position for their own babies.

7. What happens at the end of the study?

The information we obtain from the abdominal examination, ultrasound and labour and birth details will be studied carefully. We hope to see if any particular position the baby's head is in at the beginning of labour is related to a better labour and birth outcome. We will keep you up to date with the progress of the study and your contribution to the recruitment. We will present our findings to you at the completion of the study and advise you of any other relevant information related to the study. We aim to share the findings from the study with women and midwives by performing presentations and publishing the work in midwifery journals.

Appendix 2 – Information Leaflet for Midwives

8. What if something goes wrong?

It is extremely unlikely that having an additional abdominal examination and ultrasound scan will cause anything to go wrong. However if there is a problem or if the woman is not satisfied with her care, being involved in a research study does not affect her right to complain. The patient advice and liaison service (PALS) at the Birmingham Women's Hospital can inform the woman of how to make a complaint.

9. Will the information of those taking part in the study be kept confidential?

All information that is collected during the course of the research will be kept strictly confidential. Any information that leaves the hospital will have the patients' name and address removed so that individuals cannot be recognized from it.

10. What will happen to the results of the research study?

The information we obtain from the abdominal examination, ultrasound and labour and birth details will be studied carefully. We hope to see if any particular position the baby's head is in at the beginning of labour is related to a better labour and birth outcome. We aim to share the findings from the study with both yourselves and the women by performing presentations and publishing the work in midwifery journals.

11. Who is organizing and funding the research?

Birmingham Women's Healthcare NHS Trust funds the research. It will be organized by a team of four midwives and has the support of both the Medical Director and the Director of Nursing & Midwifery at Birmingham Women's Healthcare NHS Trust, the Professor of Midwifery, School of Women's Health Studies, University of Central England, and the Royal College of Midwives.

12. Who has reviewed the study?

South Birmingham Research Ethics Committee, Birmingham Women's Hospital Research & Development Committee, and the Royal College of Midwives have reviewed the study.

If you want to know more about the study or there are any issues you would like to clarify please contact: Sara Webb on Delivery Suite, 0121 472 1377 ext 2665

Bernadette Earley at the Birth Centre, 0121 472 1377 ext 6093

Appendix 3

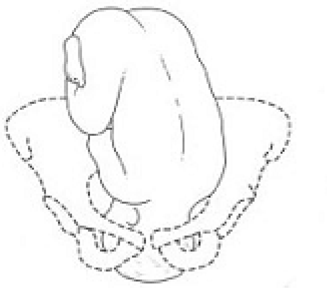
Consent Pack

A consent pack included a 4 page information leaflet for women and a consent form.

Information leaflet for women.

Birmingham Women's Health Care NHS
NHS Trust

The APOLLO Study



Analysis of fetal **P**osition at the **O**nset of **L**abour and **L**abour **O**utcomes

Information for Women

Appendix 3 – Consent Pack
(Information Leaflet for Women)

THE APOLLO STUDY

Analysis of Fetal **P**osition at the **O**nset of **L**abour and **L**abour **O**utcomes

Information Leaflet

1. Invitation to the research project

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

2. What is the purpose of the study?

We believe that the exact position a baby is lying in when it lies head down at the beginning of labour influences how labour progresses and how the baby is born. We hope this study will provide the information needed to determine if this is true.

3. Why have I been chosen?

You have been invited to take part in the APOLLO Study because you are expecting your first baby and everything is expected to be straightforward with the birth. We are inviting as many women expecting a straightforward birth with their first baby as we can to join the study. We are aiming for 1250 women in total to be involved in the study and anticipate that it will take 12-18 months to complete the study.

4. Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. You will also be given a copy of the consent form to keep. If you decide to take part you are free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive.

5. **What will happen to me if I take part?**
   A sticker will be attached to the front of your notes to indicate that you have agreed to take part.

   When you come to the hospital to have your baby you will be visited soon after admission by a research midwife. She will check first that you still wish to take part in the study. With your consent, the research midwife will feel your abdomen to find out how your baby is lying and the position of your baby's head, and also perform an ultrasound scan to confirm your baby's position. You will not be given the results of this scan, however this will not affect your care in any way.

   Your agreement will also give permission to the researchers to read your notes and collect relevant information about your labour and birth after your baby is born.

6. **What do I have to do?**
   There is nothing special that you have to do. It is standard practice that when you come to hospital to have a baby your abdomen is felt by the midwife caring for you to find out how your baby is lying and the position of your baby's head. If you agree to join the study your abdomen will be felt once more by a research midwife who will also perform an ultrasound scan just to confirm your baby's position.

7. **What are the risks?**
   Abdominal examination is not an invasive procedure and ultrasound is safe.

8. **What are the benefits?**
   We will be more certain about how your baby is lying and the position of your baby's head. Eventually we hope to collect enough information about enough women and babies to see if there is any particular position that benefits labour progress and how the baby is born. If this is shown, then we hope to be able to inform women how to promote this position for their own babies.

9. **What happens at the end of the research study?**
   If you would like to know the results of the study we will be pleased to advise you of them when the study is complete.

Appendix 3 – Consent Packs
(Information Leaflet for Women)

10. What if something goes wrong?

It is extremely unlikely that having an additional abdominal examination and ultrasound scan when you come to hospital expecting to have your baby will cause anything to go wrong. However if there is a problem or you are not satisfied with your care, being involved in a research study does not affect your right to complain. The patient advice and liaison service (PALS) at the Birmingham Women's Hospital can inform you of how to make a complaint.

11. Will my taking part in this study be kept confidential?

All information that is collected about you during the course of the research will be kept strictly confidential. Any information about you that leaves the hospital will have your name and address removed so that you cannot be recognized from it.

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14. Who has reviewed the study?

South Birmingham Research Ethics Committee, Birmingham Women's Hospital Research & Development Committee, and the Royal College of Midwives have reviewed the study.

15. Contact for further information

If you want to know more about the study or there are any issues you would like to clarify please contact:

Sara Webb on Delivery Suite, 0121 472 1377 ext 2665

Bernadette Earley at the Birth Centre, 0121 472 1377 ext 6099

Appendix 3 – Consent Form

Affix Patient ID Label here

Birmingham Women's Health Care NHS Trust

Metchley Park Road
Edgbaston
Birmingham
B15 2TG

Switchboard: 0121 472 1377

Centre: Birmingham Women's Healthcare NHS Trust
Study Number: 04-Q2707/207

CONSENT FORM

The APOLLO Study

Research into the **A**nalysis of fetal **P**osition at the **O**nset of **L**abour and **L**abour **O**utcomes

Research Team:

Sara Webb	Delivery Suite Midwife, Birmingham Women's Hospital
Aishah Bibi	Community Midwife, Birmingham Women's Hospital
Bernadette Earley	Birth Centre Midwife, Birmingham Women's Hospital
Susan Dover	Senior Midwifery Lecturer, University of Central England

Please initial box

1. I confirm that I have read and understand the information sheet dated December 2004 (version 2) for the above study and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. ☐
3. I understand that sections of any of my medical notes may be looked at by responsible individuals from Birmingham Women's Healthcare NHS Trust or from regulatory authorities where it is relevant to my taking part in research. I give permission for these individuals to have access to my records. ☐
4. I agree to take part in the above study. ☐

Name of Woman	Date	Signature
Name of Person taking consent (if different from researcher)	Date	Signature
Researcher (at time of ultrasound scan)	Date	Signature

1 copy for woman; 1 copy for researcher; 1 copy to be kept with hospital notes

APOLLO study consent form: Version 1 / September 2004

Appendix 4

Intra-Cranial Structures Used to Identify Fetal Occiput Position

The intra-cranial structures used to determine fetal occiput position included the:

- Cranial midline and thalamus gland
- Orbits
- Nasal bridge
- Cranial contour

Figure 1 demonstrates the midline structure and the thalamus gland used to identify occiput position.

Figure 1. Demonstrating cranial midline and thalamus gland

Appendix 4- Intra-Cranial Structures Used to Identify Fetal Occiput Position

Figure 2 demonstrates the identification of both orbits and the nasal bridge identifying the direct posterior fetal position (DOP).

Figure 2. Demonstrating fetal orbits and nasal bridge

Appendix 4- Intra-Cranial Structures Used to Identify Fetal Occiput Position

Figure 3 demonstrates the cranial contour, with the wide base of the hind head and occiput located posteriorly and the narrowed forehead pictured anteriorly clearly defining a direct occipito-anterior position (DOA).

Figure 3. Cranial contour identifying a direct occipito-anterior position

Appendix 4- Intra-Cranial Structures Used to Identify Fetal Occiput Position

The cranial contour is seen in Figure 4, this picture demonstrates the direct occipito-posterior position (DOP). The wide hind head is pictured anteriorly with the narrowing forehead pictured posteriorly a reversal of what was seen in Figure 3.

Figure 4. Cranial contour identifying a direct occipito-posterior position (DOP)

Appendix 5

Form B – Ultrasound Examination Form

FORM B **To be completed by Research Midwife**

Affix Patient Identification Label Here

The APOLLO Study

Participant details

Consent gained and form signed ☐ Please tick to confirm

Date of ultrasound ....

Time of ultrasound ....

Gestation at time of scan .... + ...

BMI at booking ☐

Height .... cms Weight .... Kgs

Scan comments

Appendix 5 – Form B

FORM B **To be completed by Research Midwife**

The APOLLO Study

Abdominal Ultrasound Scan Findings

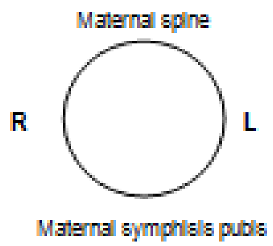
Initial check *(Please tick to confirm action carried out)*

Probe check ☐

Fetal Heart activity seen with normal rate ☐

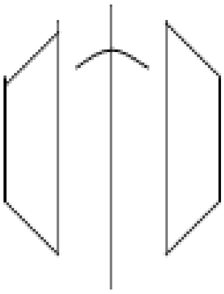
Position of fetal spine (1)

*Please mark on diagram with small '**X**' location where the fetal spine enters the pelvis*



Position of fetal spine (2)

Please draw on picture position of the fetal spine

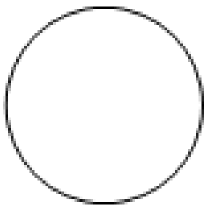


Position of vertex

Thalamus visualised?

Yes

Please draw position of thalamus below:



No *(Please tick as appropriate)*

Direct OP ☐

ROP ☐

LOP ☐

Direct OA ☐

Head too low to visualise ☐

Remember the scan pictures!

Please label and attach 2 scan pictures to this form

Placental Location

Please tick as appropriate

Anterior ☐ Posterior ☐ Fundal ☐ Lateral ☐

Appendix 6

Author’s contribution to the research study

The author is referred to as ‘the researcher’ throughout this thesis.

I was responsible for the idea and design of the research study. I had a main role in obtaining ethical approval, documenting the research protocol and formulating the methodology.

I was responsible for the overall management of the study, and performed over 90% of ultrasound scans carried out.

Finally, once the study was complete I validated the data and undertook statistical analysis.

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