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GOOD PRACTICE STATEMENT

Supine lying during pregnancy

Introduction

This statement is based on a synthesis of the best available current evidence. It will be subject to periodic review as the evidence base evolves. It should be noted that the statement offers guidance, and should not be regarded as prescriptive; such general advice will always require to be modified in line with the needs of any individual patient and the clinician's experience.

Background

In a normal healthy pregnancy, exercise is not harmful to either the mother or baby (Arena & Maffulli 2002), and physical activity throughout gestation is now recognized as having numerous beneficial effects on the mother (Evenson *et al.* 2014; ACOG 2015). However, the profound anatomical and physiological changes that occur during pregnancy also mean that special precautions are sometimes necessary.

One such safety measure is the recommendation that all late-stage pregnant women should discontinue exercising in a supine position. In a review of the literature, the Royal College of Obstetricians and Gynaecologists (RCOG) stated, "To reduce the risk of low blood pressure, you should [. . .] avoid exercises which involve lying flat on your back, particularly after 16 weeks" (RCOG 2006, p. 4). This guideline informed the POGP *Fit and Safe to Exercise in the Childbearing Year* booklet (POGP 2013). While the RCOG and POGP have attempted not to be too prescriptive or overly restrictive, the primary source for this information was not identified in either piece of literature (RCOG 2006; POGP 2013), and it is acknowledged that this message could cause concern and limit pregnant women's exercise options. The aim of the present statement is to explore the background to this precaution.

The following terms were employed to search the CINAHL, AMED, MEDLINE and EMBASE databases for results: "lying supine", "pregnancy", "exercise" and "aortocaval compression/shock".

Evidence of the effects of supine position on the pregnant woman

Cardiovascular symptoms

Marked physiological changes occur in cardiac parameters during pregnancy (Carlin & Alfirevic 2008). As gestation progresses, there are marked increases in cardiac output, stroke volume and heart rate so that sufficient nutrients and oxygen are provided for the mother and foetus (Artal & O'Toole 2003; D'Silva *et al.* 2013). These are usually well tolerated by healthy pregnant women because they experience adequate collateral venous return through the azygous and ovarian veins, and vasodilatation (Kerr *et al.* 1964).

A study by Clark *et al.* (1991) demonstrated that cardiac output fell when healthy asymptomatic pregnant women changed from lateral to supine lying during late gestation. It has been found that almost-complete occlusion of the inferior vena cava and lateral displacement of the subrenal aorta occur in supine lying during late pregnancy because of compression by the uterus. Stroke volume and cardiac output have been shown to be greatest when a woman rests on her left side, and least when she lies on her back or with the table tilted laterally to the right (Bamber & Dresner 2003). Other studies have also shown that postures such as reclined sitting and static standing can significantly affect blood flow, but it is particularly perturbed in the supine position (Artal & O'Toole 2003; Rossi *et al.* 2011). Rossi *et al.* (2011) recommended that the left lateral position should be preferred to supine lying from as early as 20 weeks gestation because the former positively affects venous return, stroke volume and cardiac output.

Aortocaval compression syndrome/inferior vena cava syndrome

Aortocaval compression (ACC) syndrome, which is thought to be the cause of supine hypotensive syndrome, occurs when the structures of the aorta and inferior vena cava in the abdomen

are compressed by the pregnant uterus (Bamber & Dresner 2003). Aortocaval compression reduces cardiac output, but this is often concealed by sympathetic compensation, and can result in no signs or symptoms for the healthy pregnant woman. Objectively, a decrease in systolic arterial blood pressure of at least 15–30 mmHg identifies ACC (Kinsella & Lohmann 1994; Lee *et al.* 2012). Signs of ACC syndrome include pallor, dizziness, low blood pressure, sweating, nausea and increased heart rate. In severe cases, women can experience a loss of consciousness. Symptoms usually occur within 3–10 min of lying down, but these are transient and resolve if the mother changes position to left-side tilt or sitting (Rees & Willis 1988; Paech 2008; Kim & Wang 2014).

Pressure on the femoral veins has been recorded in supine lying from 16 weeks, but symptoms of ACC are rarely recorded before 20 weeks of pregnancy, when the uterus has risen out of the pelvis. These peak by 28–32 weeks. Identified risk factors for ACC syndrome include: the increased size, shape and weight of the uterus; excess amniotic fluid (polyhydramnios), which is more common in multiple pregnancy; women with a body mass index (BMI) in the obese range; and cases of pre-existing heart disease (Rossi *et al.* 2011; De-Giorgio *et al.* 2012; Kienzl *et al.* 2014). The results of one study indicated that 8–10% of pregnant women demonstrate signs of severe ACC syndrome (Lanni *et al.* 2002).

Lee *et al.* (2012) showed that a woman's cardiac output is improved by placing a firm wedge under her hip to create a 15° lateral tilt since gravity is thought to displace the foetus and uterus laterally. This was confirmed by Dohi *et al.* (2016), who demonstrated that a lateral tilt of 15–20° causes left uterine displacement, and is the optimal position for maternal cardiopulmonary resuscitation. Guidelines suggest that a 15° left-lateral tilt (LLT) position prevents ACC until 26 weeks of gestation, but Summers *et al.* (2011) argued that this may be inadequate to offload the vena cava and normalize the circulation after this time. The above study showed that the right lateral position should be avoided because of the resultant low coronary perfusion pressure and brain oxygen saturation. Shonfeld *et al.* (2013) suggested that the tilt and wedge should be the gold-standard position for Caesarean section. The following question arises: is this tilt position adhered to when women are in the lithotomy position, especially since aortic compression is reportedly more evident in labour (Higuchi *et al.* 2015)?

Despite the LLT position being accepted practice, there is a paucity of research into what constitutes an adequate amount of lateral tilt. Higuchi *et al.* (2015) measured the volumes of the aorta and inferior vena cava in multiple LLT positions. The aorta was slightly compressed in the 15° LLT position, and deformed at 30° and 45°, but volume was not affected. In contrast, inferior vena cava volume was significantly increased in the 30° and 45° LLT positions; however, these postures may cause the patient to slide or roll off the inclined plane. Higuchi *et al.* (2015) described a 27° tilt as giving the optimum compression force, but their study did not allow for acclimatization in the LLT position. They reported that abdominal relaxation displaces the pregnant uterus more to the left. A study by Saravanakumar *et al.* (2016) indicated that there was a non-statistically significant improvement in ACC syndrome with a 15° reverse Trendelenburg position (feet down) and pelvic tilt in obese pregnant women.

The National Institute for Health and Care Excellence (NICE, formerly the National Institute for Health and Clinical Excellence) pregnancy guidelines (NICE 2008) make no mention of either ACC syndrome or supine lying with regard to sleeping, exercise, labour and intercourse. Although there is considerable evidence regarding static supine lying and its effects on maternal circulation, there are no conclusive findings about the effects of supine lying during exercise. It could be hypothesized that contralateral circulation in a normal healthy pregnant woman is able to accommodate to supine lying, and that active exercise would increase venous return. It must be acknowledged that the symptoms of ACC syndrome experienced by a pregnant woman are pronounced, and represent a natural warning system that should tell her to change position. If she is comfortable and no symptoms are evident, she will be able to continue to lie in supine during exercise.

Respiratory symptoms

Sleep-disordered breathing and snoring are common when lying in supine during pregnancy (Izci *et al.* 2006), and narrowing of the upper airways during the third trimester has been confirmed. However, this does not affect foetal growth in healthy pregnant women (Tauman *et al.* 2012). Studies of the effects of different maternal positions on the results of the foetal

non-stress test (NST) have found that women report that the supine position is uncomfortable, and dyspnoea is one of their most frequent complaints (Aluş *et al.* 2007; Sekhavat & Tabatabaei 2014). Women with pre-eclampsia and chronic hypertension experience airway narrowing in supine postures, and have the potential to suffer from sleep apnoea, which may further increase their blood pressure while sleeping (Izci *et al.* 2002; Champagne *et al.* 2010). The available literature regarding the effects of supine lying on respiratory function makes no recommendation to avoid this position.

Renal symptoms

As highlighted previously, almost complete occlusion of the inferior vena cava and lateral displacement of the subrenal aorta at the level of entry of the renal veins occurs during supine lying (Bamber & Dresner 2003). Because there is no adequate alternative drainage, this displacement increases renal venous pressure (Kerr *et al.* 1964), which may result in oliguria and decreased sodium output. The available literature does not suggest that the supine position should be avoided to combat this.

Musculoskeletal symptoms

During pregnancy, women are susceptible to the external environment, which can induce musculoskeletal pain (Hezel 2017). Low back pain can occur in pregnancy as a result of changes in spinal muscle length and posture (Greenwood & Stainton 2001). For comfort, pregnant women will often naturally avoid lying in supine. Studies such as that of Belogolosky *et al.* (2015) have reported that a range of exercises in positions including supine lying significantly improve function and ease pregnancy-related pain.

Evidence of the effects of maternal supine position on the foetus

Uterine blood flow and its effect on cerebral blood flow: the "brain-sparing effect"

The compression of the inferior vena cava, and the resulting decrease in venous return and cardiac output causes distribution to flow away from the splanchnic and uterine circulation. The blood flow in the ascending branch on the uterine artery has been shown to decrease by 34% during supine rest compared to the LLT position (Kauppila *et al.* 1980; Jeffreys *et al.* 2006).

A change in uterine blood flow may compromise foetal oxygenation and induce a "brain-sparing effect" (Khatib *et al.* 2014; El-Shahawy *et al.* 2016). Brain sparing, or foetal cerebral distribution, is a vascular adaptation that is characterized by the preferential flow of oxygenated blood towards the central nervous system and foetal brain at the expense of other organs (Baschat 2004). Studies by Khatib *et al.* (2014) and El-Shahawy *et al.* (2016) demonstrated that brain sparing could be activated by physiological stresses such as the maternal supine position. Although El Shahawy *et al.*'s (2016) results indicated that the changes in cerebral blood flow indices were within the normal range in both low- and high-risk pregnancies, these authors concluded that, "Supine positioning of pregnant women during any kind of lengthy diagnostic or therapeutic intervention should be avoided" (El-Shahawy *et al.* 2016, pp. 240 & 253). A study by Jefferys *et al.* (2006) investigated uterine blood flow in supine exercise in comparison to rest. These authors found that the decrease in the flow of blood at rest was twice as much as that occurring during exercise, and that the level of blood flow should not be a cause for concern in healthy asymptomatic women who choose to exercise in a supine position in late pregnancy (Jefferys *et al.* 2006).

Foetal non-stress test

The NST is a widely used screening tool for the assessment of foetal well-being that monitors a baby's heart rate in response to its activity. A reactive NST result is an indication that the flow of blood and oxygen to the foetus is adequate. Studies comparing the effect of maternal positions on NST results found that these were most non-reactive and reactive in the supine and lateral positions, respectively. This suggests that the supine position causes a decrease in placental perfusion and a lower foetal heart rate (Nathan *et al.* 2000; Aluş *et al.* 2007; Sekhavat & Tabatabaei 2014).

Foetal behavioural state

The foetal behavioural state (FBS) is a measure of foetal well-being that assesses the neurological integrity of the foetus (Romanini & Rizzo 1995), and the development of heart autonomic control (Brändle *et al.* 2015). Stone *et al.* (2017) examined the effect of maternal position on FBS in healthy women between weeks 35 and 38 of gestation. Four maternal positions (i.e. supine, semi-recumbent, and left and right lateral) were

studied overnight to calculate foetal heart rate (FHR) variability (FHRV). The results showed that maternal position in late pregnancy had significant effects on FHR and measurements of FHRV in the supine position, as compared to the left or right lateral postures. The foetal state of quiet sleep is more likely to occur if the baby has to adapt to mild hypoxic stress. The reduction in placental perfusion results in the foetus entering a low-oxygen-consuming state as a protective adaptation. Stone *et al.* (2017) reported that foetuses may not be able to adapt to supine lying if they are unhealthy; for example, when they exhibit poor growth. This research suggests that there is satisfactory evidence to recommend that mothers avoid sleeping on their backs in late pregnancy because of the effect that this can have on their babies.

Low birth weight and increased risk of stillbirth

Five studies of late-gestation stillbirth have described the importance of maternal sleep position and the risk of intrauterine death (Stacey *et al.* 2011; Owusu *et al.* 2013; Gordon *et al.* 2015; Heazell *et al.* 2017; McCowan *et al.* 2017).

Owusu *et al.* (2013) found that women who reported "commonly" sleeping in a supine position during their pregnancies increased their risk of stillbirth or having a baby with a low birth weight. Further case-control studies have supported the possible association between maternal sleep position and the risk of late stillbirth, concluding that women who sleep on their backs are at increased risk of late stillbirth (Stacey *et al.* 2011; Gordon *et al.* 2015; McCowan *et al.* 2017). The Sydney Stillbirth Study stated that supine sleeping alone did not necessarily increase the risk of stillbirth, but constituted an additional risk during late pregnancy for a foetus that had already been compromised (Gordon *et al.* 2015).

Heazell *et al.* (2017) reported that, irrespective of other common risk factors, going to sleep, returning to sleep and napping in a supine position are all associated with a 2.3-fold increase in the risk of stillbirth after week 28 of gestation, a risk of 3.7%. The women who participated in this study also reported both long and short sleep durations (long sleep was defined as >8 h), got up to use the toilet no more than once during the night and took a daytime nap. Heazell *et al.* (2017) identified maternal ACC syndrome and foetal hypoxia as plausible reasons for late stillbirth, and recommended that women in the third trimester of pregnancy should avoid going to sleep in a supine position. Left-sided sleeping was not conclusively shown to decrease the risk of stillbirth.

It is important to emphasize that all the research discussed in the present statement only describes "supine sleep", i.e. a prolonged period of rest in this position, as a potential risk. The results do not apply to adopting this posture for a shorter duration, such as when a mother is also being physically active, and none of the studies described investigated exercise in a supine position.

Conclusions

Overall, exercise can be safe and beneficial to both a mother and foetus during pregnancy, and should be encouraged (ACOG 2015). After consideration of the available evidence about maternal position in pregnancy, it can be concluded that lying in supine does influence the haemodynamics of maternal and foetal placental circulation. There is little literature that specifically addresses exercising in a supine position during pregnancy. To date, there appears to be no recognized research to support the premise that exercising in supine lying could negatively impact foetal development.

Based on the available evidence, physiotherapists should clinically evaluate pregnant women on an individual basis, and take any medical risks into consideration before providing advice on exercising in a supine position:

- Screen women who attend for exercise for signs of ACC syndrome from week 19 of gestation onwards. These indications include pallor, dizziness, low blood pressure, sweating, nausea and an increased heart rate. Symptoms usually occur within 3–10 min of lying down, and are reversed by a change in position. If these signs are identified, ensure that these details are included in the obstetric notes and relevant staff are informed.
- Identify women who are at risk. These include those who smoke, and any patients with: pre-existing heart disease; restrictive lung disease; any medical condition that causes maternal hypoxia or hypotension; and a high BMI. Women who have undergone multiple pregnancies are also at risk.
- Identify foetal risks such as a history of being small for gestational age, intrauterine growth restriction or reduced foetal movements.

If any of the risks described above are identified, it is advisable for women to avoid exercise

in supine lying, and select an alternative position, such as an upright posture or left-side lying. They should be advised to avoid resting motionless in the supine position, and be provided with guidance on LLT positions for resting. There is some evidence to suggest that raising the head 15° above the feet may be beneficial (Saravanakumar *et al.* 2016).

In a normal healthy pregnancy, women in the first and second trimesters should be reassured that resting and sleeping in any position that they find comfortable is safe for both them and their foetuses. Pillows can provide support and symmetry, and women should move into different positions for comfort during the night. In the third trimester, there is evidence to support the recommendation that mothers-to-be should avoid going to sleep on their backs because of the effect that this can have on their babies, and the increased risk of stillbirth.

For normal healthy pregnant women who show no signs of ACC syndrome or the risk factors identified above, physiotherapists should consider the length of time that they adopt the supine position during exercise, and consider alternative postures. Those who teach antenatal group exercise or relaxation should encourage all attendees to avoid the supine position, thereby minimizing any risk to those with known or unknown ACC syndrome. Prior to any exercise in supine lying, physiotherapists should advise pregnant women to change to the LLT position or sitting if they experience any dizziness or begin to feel unwell.

Although this good practice statement is primarily concerned with advice for exercising in supine lying in pregnancy, consideration should also be given to other activities that may involve women spending prolonged periods on their backs; for example, examinations, investigations, bathing, reclined sitting, labour and intercourse.

For further reading, see Kauppila *et al.* (1980), Marx *et al.* (1980), Janicak *et al.* (2008), Kalisiak & Spitznagle (2009), Kim *et al.* (2011), Lewis (2014), Ayres-de-Campos *et al.* (2015) and Resuscitation Council (UK) (2017).

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