

Applying Scientific Rationale to the Current Perceptions and Explanations of Massage and Miscarriage in the First Trimester

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<https://doi.org/10.3822/ijtmb.v16i1.771>

Miscarriage is a relatively common occurrence, impacting 8–15% of clinically recognised pregnancies, and up to 30% of all conceptions. The public perception of the risk factors associated with miscarriage does not match the evidence. Evidence indicates that there are very few modifiable factors to prevent miscarriage, and the majority of the time little could have been done to prevent a spontaneous miscarriage. However, the public perception is that consuming drugs, lifting a heavy object, previous use of an intrauterine device, or massage can all contribute to miscarriage. While misinformation about the causes and risk factors of miscarriage continues to circulate, pregnant women will experience confusion about what activities they can (and cannot) do in early pregnancy, including receiving a massage.

Pregnancy massage is an important component of massage therapy education. The resources that underpin pregnancy massage coursework consist of educational print content that includes direction and caution that massage in the first trimester, if done ‘incorrectly’ or in the ‘wrong’ location, can contribute to adverse outcomes such as miscarriage. The most common statements, perceptions and explanations for massage and miscarriage cover three broad areas: 1) maternal changes from massage affects the

embryo/fetus; 2) massage leads to damage of the fetus/placenta; and 3) aspects of the massage treatment in the first trimester initiate contractions.

The goal of this paper is to use scientific rationale to critically consider the validity of the current perceptions and explanations of massage therapy and miscarriage. Whilst direct evidence from clinical trials was lacking, considerations of physiological mechanisms regulating pregnancy and known risk factors associated with miscarriage provide no evidence that massage in pregnancy would increase a patient’s risk of miscarriage. This scientific rationale should be addressed when teaching pregnancy massage courses.

KEYWORDS: Massage; miscarriage; first trimester

INTRODUCTION

Massage and Miscarriage

Massage “is a patterned and purposeful soft-tissue manipulation accomplished by use of digits, hands, forearms, elbows, knees and/or feet, with or without the use of emollients, liniments, heat and cold, hand-held tools or other external apparatus, for the intent of therapeutic change”.⁽¹⁾ Pregnancy massage is a popular aspect of

massage therapy. Pregnancy massage is usually taught as part of a therapist's initial massage training or as a post-massage qualification course;⁽²⁾ however, some pregnancy massage therapists choose to provide pregnancy massage in the first trimester without any pregnancy massage training.⁽²⁾ The resources that underpin pregnancy massage coursework often include clinical experience, experts from other health fields, previous study, massage trade publications, and pregnancy massage textbooks. A small number of subject matter experts agree that pregnant people can safely receive a massage in their first trimester if they are well and they do not have any other contraindications.⁽³⁻⁹⁾ However, this message is not reflected in practice, with just over 25% of massage therapists providing pregnancy treatments agreeing or strongly agreeing with the statement 'massage should be avoided in the first trimester'.⁽²⁾ Despite much folklore to the contrary, no published evidence suggests that massage causes miscarriage.^(8,9) However, many massage textbooks and a number of the massage trade publications include some direction and caution that massage in the first trimester, if done 'incorrectly' or in the 'wrong' location can be harmful or risky.^(3,6,7,10-15) This belief that massage in the first trimester is harmful may be influencing pregnancy massage research studies, with only limited research including pregnant women in the first trimester in their cohort.⁽¹⁶⁾ Indeed, a recent review on effects, side effects, and contraindications of massage only found studies where women were treated from 14 weeks gestation.⁽¹⁷⁾ Massage therapists and educators who believe that massage, if not done 'correctly' or in the 'right' location can be harmful or risky during the first trimester, perpetuate the cycle of misinformation on pregnancy massage in the first trimester both within the profession and, more broadly, to consumers and other health professionals. The inconsistent messages pregnant women receive about the risk of massage undermine consumers' feeling of safety and make them feel uncomfortable.⁽¹⁸⁾

Around 50% of miscarriages are 'unexplained',^(19,20) leaving space for individuals to hypothesize about potential causes. It is understandable for women to want to know why a miscarriage happened, so that another one might be prevented.

However, despite there being extremely limited modifiable factors to prevent miscarriage, public perception does not match this with common beliefs that having a fall,⁽²¹⁾ consuming drugs,^(21,22) stress,⁽²¹⁻²³⁾ lifting a heavy object,⁽²³⁾ previous use of an intrauterine device,⁽²³⁾ oral contraceptives,⁽²³⁾ and supernatural forces such as God's will and evil eye⁽²²⁾ are all causative factor for miscarriage. Thus, conversely, "resting, avoiding stress and upset, maintaining a healthy diet, and spiritual healing (ruqyah) are seen as a means to avoid miscarriage".⁽²²⁾ This indicates that, despite the growing evidence about the aetiology and risk factors of miscarriage, more education about the real causes for these upsetting events is needed. As long as the causes of miscarriage remain obscure, misinformation will continue to circulate about what activities people in early pregnancy should or should not do, including whether it is safe to receive massage. The aim of this paper is to apply scientific rationale to the current perceptions and explanations on massage and miscarriage, to critically consider their validity.

What Is Spontaneous Miscarriage?

Spontaneous miscarriage, sometimes referred to as spontaneous abortion,⁽²⁴⁾ is a pregnancy that ends spontaneously, either before 20 weeks of gestation (the normal definition in the US and Australia) or before 28 weeks of gestation (as defined by the World Health Organization).⁽²⁴⁻²⁷⁾ Miscarriages that occur prior to four weeks of gestation (equivalent to 14 days post-conception) are termed biochemical miscarriages, as women would often not have been aware they were pregnant, and the very early products of conception are shed with their menstrual period. Biochemical miscarriages are estimated to affect 30% of all conceptions.⁽²⁸⁾ Early miscarriage is defined as occurring before 12–13 weeks of gestation,^(29,30) and late miscarriage from 12 to 20–28 weeks of gestation.^(29,30) Miscarriage is a relatively common occurrence. Once a pregnancy is clinically detected, between 10% and 25% of pregnancies will miscarry within the first trimester.^(24,31,32)

The Aetiology of Spontaneous Miscarriage

The most common cause of miscarriage is chromosomal/genetic abnormalities,

leading to ~50% of spontaneous miscarriages (Figure 1).^(21,33,34) Genetic abnormalities most frequently occur due to aneuploidy—when the chromosomes fail to separate properly during cell division—meaning that some cells have extra copies of a particular chromosome while others have none.⁽³⁵⁾ The exact causes of aneuploidy are not well understood, although increased maternal age (>35 yrs) is the greatest risk factor.⁽³⁶⁾ The remaining 50% of spontaneous miscarriages are attributed to failures of early placental development (Figure 1).⁽¹⁹⁾ As causes of miscarriages resulting from impaired early placentation are difficult to define or diagnose, these are often referred to as ‘unexplained’ miscarriages.⁽²¹⁾

A number of factors are associated with a higher risk of miscarriage. Several of these are modifiable including heavy alcohol use,⁽³⁷⁾ smoking,⁽³⁸⁾ and weight (both obesity and being underweight),⁽³⁹⁻⁴⁰⁾ although it is important to note that recent evidence has highlighted a genetic component to weight, making obesity less modifiable for some individuals.⁽⁴¹⁾ Of particular relevance to the massage field, an association between higher levels of maternal stress and an increased risk of spontaneous miscarriage has been reported,^(40,42) although findings in this area are not consistent.⁽⁴³⁻⁴⁵⁾ Non-modifiable risk factors associated with an increased

risk of miscarriage include increasing maternal and paternal age,^(46,47) non-treated subclinical hypothyroidism,⁽⁴⁸⁾ and high or very high levels of morbidity.⁽³⁴⁾ However, it is important to highlight that these risk factors are associations, and clear causative mechanistic links between fetal and placental factors leading to spontaneous miscarriage (aneuploidy, impaired placental development), and maternal risk factors associated with higher rates of spontaneous miscarriage at a population level are not well defined.

What Is Recurrent Miscarriage?

Recurrent miscarriage is most accurately defined as three or more miscarriages in a row with the same partner,⁽²⁷⁾ although some sources use a definition of two or more miscarriages.⁽⁴⁹⁾ One to three percent of couples will experience recurrent miscarriage.^(27,49) Unlike spontaneous miscarriage, recurrent miscarriage is considered a clinical disorder for which women should actively seek medical help to enable diagnosis and treatment of potential causes.

The Aetiology of Recurrent Miscarriage

The general aetiological factors for recurrent miscarriage are similar to spontaneous miscarriage including genetic,

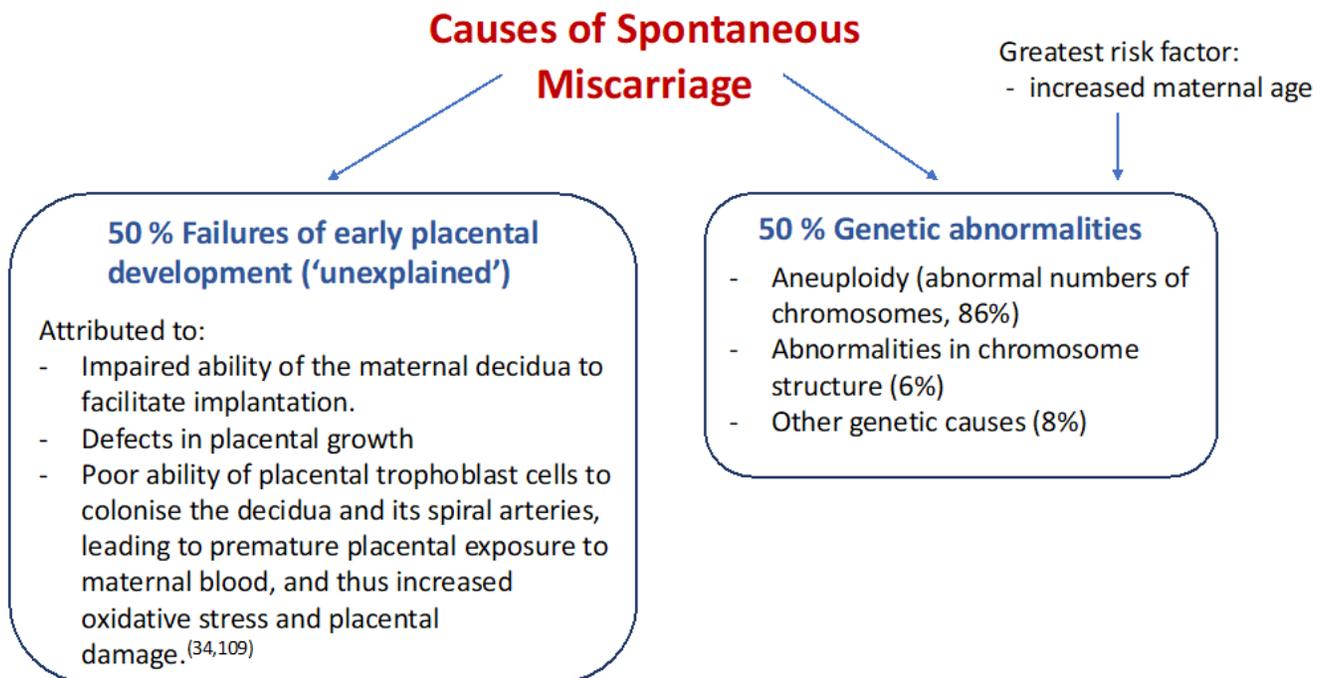


FIGURE 1. Cases of spontaneous miscarriage

endocrine, anatomical, and immunological abnormalities (Figure 2).⁽⁵⁰⁾ However, the difference is that here miscarriages occur more often than is the result of random chance, meaning that there is likely a consistent underlying maternal physiological factor involved. Like spontaneous miscarriage, genetic abnormalities play a role in recurrent miscarriage, although these make up a smaller proportion of overall cases as the ‘random chance’ of aneuploidy is unlikely to occur in three consecutive pregnancies. However, overall higher rates of blastocyst aneuploidy⁽⁵¹⁾ combined with an impaired ability of the decidua to sense embryo quality may mean that a higher rate of abnormal embryos implant, leading to a greater rate of clinically detectable miscarriages, rather than implantation failure/infertility.⁽⁵²⁾ Non-random genetic components also likely play a role in recurrent miscarriage, with higher rates of balanced translocations in the parental genomes compared to the general population, and a familial association.⁽⁵³⁾ Finally, despite the number of known contributing factors discussed above, almost half of cases of recurrent miscarriage remain unexplained.⁽⁵⁴⁾ Supportive care plays an important role in improving outcomes for recurrent miscarriage patients.^(20,55) This involves a combination of medical support

(i.e., working with a medical professional to identify possible causes and potential avenues of treatment, and enabling increased ultrasound monitoring of further pregnancies),⁽⁵⁵⁻⁵⁷⁾ as well as non-medical supportive care such as listening and understanding what women are feeling, experiencing supportive care from family, friends, and peer groups, and relaxation tools to manage stress. Importantly for massage therapists, some women indicated that massage for relaxation was a preference for inclusion in non-medical supportive care.^(56,57)

MASSAGE AND MISCARRIAGE STATEMENTS

A search of pregnancy massage textbooks and massage trade publications, encompassing over 15 sources, was undertaken. This revealed a number of consistently arising statements that gave direction and or caution that massage in the first trimester, if done ‘incorrectly’ or in the ‘wrong’ location, was harmful or risky. We focus on the most common perceptions and explanations. Statements were made covering three broad areas: 1) maternal changes from the massage affecting the embryo/fetus;⁽¹¹⁻¹³⁾ 2) massage leading to damage of the fetus/placenta;^(6,12) and

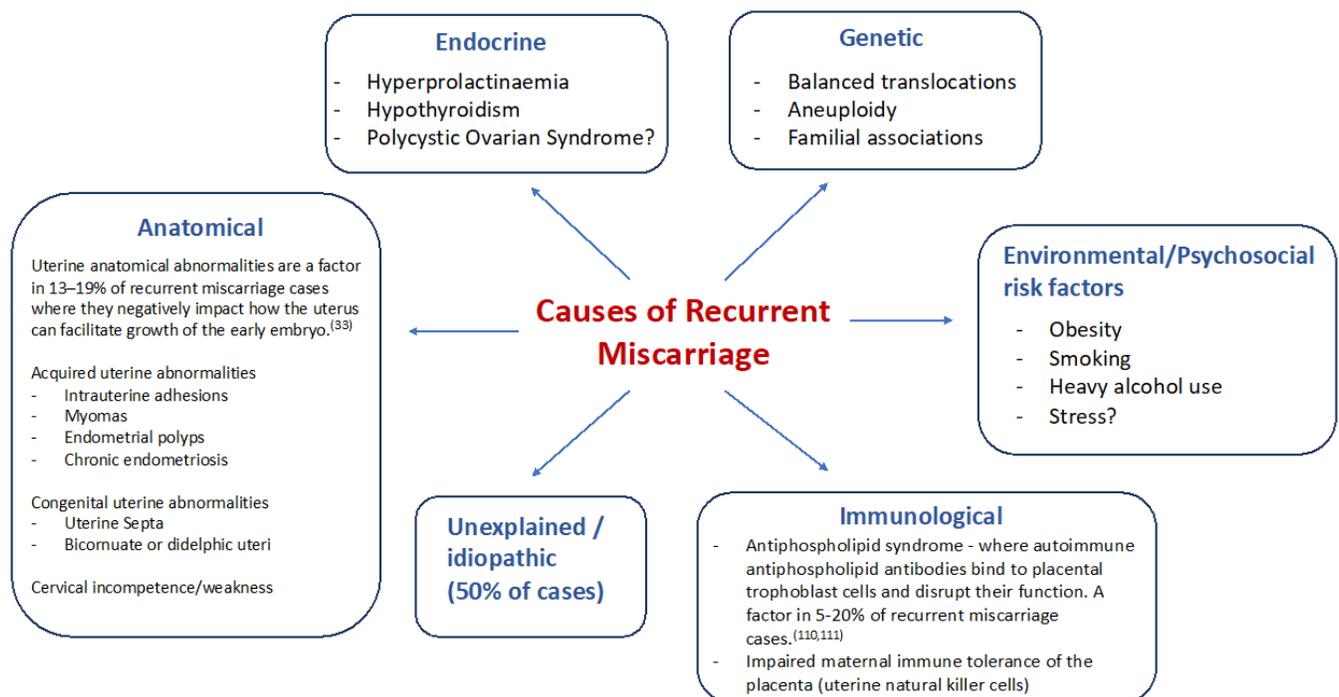


FIGURE 2. Causes of recurrent miscarriage

3) aspects of the massage treatment in the first trimester initiating contractions.^(3,6,11-15) We will use scientific evidence and rationale to address each concern.

1. Maternal Changes From the Massage Affecting the Embryo/Fetus

Concern: Massage may impact implantation. It has been stated that massage should be avoided in the post-ovulation luteal phase as a full body massage is very stimulating to the circulatory system and, just like a ship trying to dock and coming into port, a tiny embryo has the best chance of implanting in 'still waters', not 'choppy seas'.^(58,59)

Scientific evidence and rationale: This statement has several problems. The first is that fertilisation occurs in the fallopian tube, and the early embryo does not implant until around seven days post-conception.⁽⁶⁰⁾ Thus, it is not exposed to the circulatory system in the first week following conception, and so stimulating blood flow is unable to affect this process. Upon reaching the uterine cavity, the blastocyst adheres to and invades into the decidua as the first cells of the placenta grow and develop.⁽⁶⁰⁾ Around Day 12 post-conception, the early placenta breaches small uterine blood vessels for the first time, creating small blood filled 'lacunae' at its periphery.⁽⁶⁰⁾ However, at this point the developing embryo is completely encapsulated within the decidua, which has healed over the top of the implantation site, and could not be physically dislodged by changes in blood flow.

Concern: Maternal circulatory changes from massage in the first trimester affect the fetus. Both increasing and decreasing blood flow to the uterus during a massage have been postulated to increase the risk of miscarriage.^(7,11)

Scientific evidence and rationale: We are aware of no studies that have directly measured changes in uterine blood flow (for example by uterine artery Doppler ultrasound) during or after massage. For most of pregnancy, maternal blood flow to the surface of the placenta is important to deliver sufficient nutrients and oxygen to the baby.⁽⁶¹⁾

When considering how massage may affect uterine/placental blood flow, there

are two key considerations. First, during the first trimester (when most miscarriages occur), placental trophoblast cells invade the uterus and form significant 'plugs' in the vessels closest to the placenta (the spiral arteries), which prevent significant maternal blood flow to the placenta, meaning that the placenta/fetus normally develop in a low oxygen environment in early pregnancy, and this is important for pregnancy success.⁽⁶²⁻⁶⁴⁾ Secondly, the larger vessels in the uterus also undergo dramatic remodelling, doubling in size by mid-pregnancy and, from the second trimester (when the 'plugs' break down), these vessels play a rate-limiting role in controlling blood flow to the placenta.⁽⁶²⁾ This process is driven by hormones released from the placenta, which allow the vessels to remain dilated, enabling a 15-fold increase in blood flow to the uterus across pregnancy.⁽⁶¹⁾ The extent of these combined normal physiological changes, and their regulation by multiple placenta-driven mechanisms, means that it is highly unlikely that small increases in systemic muscle tissue oxygenation and muscle tissue blood volume induced by massage⁽⁶⁵⁾ would significantly impact utero-placental blood flow. However, we consider the two main concerns (increased or decreased flow) specifically below.

Concern 1: Decreased blood flow to the uterus from massage techniques. It is stated that massage techniques may increase the risk of miscarriage by increasing the blood flow to other areas of the body, leading to a decrease in blood flow to the uterus.⁽¹¹⁾

Scientific evidence and rationale: Redirection of blood flow to skeletal muscle and an increase in heart rate also occurs during exercise (to a greater extent than massage), and maintenance of a moderate exercise programme is recommended throughout pregnancy and is not associated with changes in uterine blood flow or an increase in miscarriage rates.⁽⁶⁶⁻⁶⁸⁾ Furthermore, in the first trimester, plugging of the uterine spiral arteries means that blood flow to the placenta is very limited at the time many miscarriages occur, and low levels of blood flow to the placenta at this point are, in fact, important for a healthy pregnancy.⁽⁶⁹⁾

Concern 2: Increased blood flow during a massage might be harmful.

Massage therapists have raised concerns that the dramatic increase in blood flow that occurs during a massage could increase the risk of miscarriage.^(7,14)

Scientific evidence and rationale: Massage induces small increases in skeletal muscle tissue oxygenation and muscle tissue blood volume.⁽⁶⁵⁾ However, no evidence shows that these changes in systemic blood flow have a significant impact on utero-placental blood flow. Early increases in blood flow to the developing placenta would indeed be potentially damaging; however, multiple mechanisms exist to protect against this. In the event that uterine blood flow was increased in the first trimester, this would be prevented from reaching or damaging the placenta via the plugging of the spiral arteries.⁽⁷⁰⁾ Abnormal increases in uterine blood flow at this time can also bypass the placenta via arterio-venous shunts in the uterus upstream of the plugged spiral arteries.^(61,71,72) This mechanism acts like the overflow of water from a dam, providing a low resistance alternate pathway for blood flow that mitigates against dangerously high pressures or volumes of flow reaching the placenta.⁽⁷³⁾

Concern: Massage in the first trimester disturbs the natural hormonal process. It is said that the hormonal changes that occur in the first trimester, particularly the role of human chorionic gonadotropin (hCG), progesterone, and oestrogen, are vital for the healthy development of the fetus, and that, while that “massage is unlikely to...disturb the natural hormonal process”(p10),⁽¹²⁾ “since this is such a delicate and important time for the expectant mother, it is best to avoid any possible complications”(p10).⁽¹²⁾

Scientific evidence and rationale: No evidence shows that massage in the first trimester can lower hormone levels (hCG, progesterone and or oestrogen), either as a result of the massage itself, or due to secondary ‘physical stress’ caused by the massage. A normal menstrual cycle prepares the endometrium to support an implanting blastocyst.⁽⁷⁴⁾ If implantation does not occur, a decrease in ovarian progesterone production in the later part of the cycle leads to the endometrial shedding during menstruation.⁽⁷⁴⁾ However,

if implantation occurs, hCG produced by the early placenta induces the ovary to maintain progesterone production to enable a uterine environment favourable to pregnancy.⁽⁷⁴⁾ The placenta then takes over the role of progesterone production from the ovary to sustain the pregnancy.⁽⁷⁴⁾ As these hormones are produced exclusively (hCG) or dominantly (progesterone) by the placenta during pregnancy, no evidence or physiological rationale suggests that massage can alter the production of these hormones, let alone to do so in a way that could either induce, or ‘aide’ in the prevention of, a miscarriage.

Concern: Avoiding pain during the massage treatment in the first trimester. Several authors make statements such as: “It is essential that all massage movements are carried out without inflicting pain on the recipient. This is because hormones that are released in response to pain have the effect of elevating blood pressure, respiration rate, and heart rate, while at the same time lowering immunity and blood flow to the uterus”.^(9,11-13) It is stated that the hormone signals “diffuse into fetal circulation through the placenta”,⁽¹¹⁾ negatively impacting the fetus. No evidence suggests that pain experienced during massage results in a significant hormone release; however, we consider effects of elevating blood pressure, respiration, and heart rates, as well as the hormone release in response to pain and lowering of immunity.

Concern: Pain during a massage elevates blood pressure, respiration and heart rate.

Scientific evidence and rationale: Acute pain elevates blood pressure, and increases heart and respiration rates.⁽⁷⁵⁾ However, there is no evidence that transient increases in any of these factors increase miscarriage risk. Indeed, such changes are routinely observed when pregnant women undertake moderate exercise, which is not contraindicated in pregnancy, and is not associated with increased miscarriage rates.^(67,68) Data on women with chronically elevated blood pressure also suggests that this is not an independent causative factor of miscarriage (although it is associated with obesity, a known risk factor), further reducing concerns around transient increases in blood pressure during massage.^(76,77)

Concern: Hormones released in response to pain during massage negatively affect the fetus.

Scientific evidence and rationale: In response to acute pain the body releases hormones including endorphins, enkephalins, oxytocin, and cortisol, some of which have analgesic effects. Interestingly, during pregnancy higher levels of estrogen enhance this hormonal pain response⁽⁷⁸⁾ and, as a result, many chronic pain conditions improve in pregnancy.⁽⁷⁹⁾ There is no evidence that physiological levels of endogenous opiates (endorphins and enkephalins) increase the risk of miscarriage. Indeed, endorphins are released in response to both exercise and pain, and exercise has not been shown to have a negative impact on pregnancy.^(67,68,80) Baseline plasma oxytocin levels vary considerably between pregnant women and across pregnancy, and no causative link between altered oxytocin levels and miscarriage has been established.⁽⁸¹⁾ Indeed, whilst a key player in the progression of labour, oxytocin alone is unable to initiate the onset of labour.⁽⁷⁴⁾ Finally, cortisol is released in response to both pain and psychological stress. In normal pregnancy, maternal cortisol levels rise from the end of the first trimester, reaching almost three times those in non-pregnant women by term,⁽⁸²⁾ and this plays important roles in fetal organ development.⁽⁸³⁾ To protect the fetus from elevated maternal cortisol, the placenta breaks maternal cortisol down into inactive cortisone via production of the enzyme 11β -hydroxysteroid dehydrogenase. Whilst the impact of short term increases in cortisol in response to pain (induced by massage or otherwise) have not been examined, acute stress (in this case amniocentesis) causes an increase in placental 11β -hydroxysteroid dehydrogenase, which would help mitigate short term increases in cortisol, and prevent transfer to the fetus.⁽⁸⁴⁾

Concern: Hormonal changes from massage lower maternal immunity and can affect the fetus.

Scientific evidence and rationale: The immune system plays an important role in pregnancy, and large numbers of uterine-specific immune cells are found in the maternal decidua in close proximity to invading placental trophoblast

cells.⁽⁸⁵⁾ Compared to systemic immune cells that are primarily involved in pathogen defence, uterine immune cells have distinct phenotypes and rather act to promote successful implantation by helping remodel the uterine blood vessels to support pregnancy, and engaging in cross-talk with invading placental cells to enable immune tolerance of the genetically foreign placenta and fetus.⁽⁸⁵⁾ Whilst the effects of massage on uterine-specific immune populations has not been directly examined, there is no reason to think massage would have a negative impact on these cells or their interaction with the developing placenta.

2. Massage Leading to Damage of the Fetus/Placenta

Concern: Massage releases toxins that damage the developing fetus. In many instances the exact 'toxins' referred to in these statements are undefined. Hence, here we focus on specific defined concerns that lactic acid released during a massage might reach the unborn baby.⁽⁸⁶⁾

Scientific evidence and rationale: There is mixed evidence about massage and lactic acid in the blood stream. Massage techniques such as effleurage, petrissage, and stripping strokes after exercise did not significantly increase muscle lactic acid release;^(87,88) however, trigger point release massage resulted in increased dialysate lactate concentrations.⁽⁸⁹⁾ Lactate can cross into the placenta from the maternal circulation;^(90,91) however, the notion that lactic acid is toxic to the placenta or fetus is incorrect. Rather, anaerobic glycolysis (resulting in lactic acid production) is an important metabolic pathway in the placenta, which converts about a quarter of the glucose it takes up to lactic acid.⁽⁹²⁾ Indeed, lactate may be an important fetal and placental energy source even when oxygen and glucose supplies are adequate, and the extent of placental reliance on anaerobic metabolism likely reduces placental oxygen consumption, enabling greater oxygen transfer to the fetus.⁽⁹³⁾ In line with this, at term in normal pregnancy concentrations of lactic acid are higher in fetal blood than maternal blood.⁽⁹⁴⁾ Like muscle, the placenta increases production of lactic acid to help mitigate the effects of reduced oxygen on fetal metabolism and

growth.⁽⁹⁵⁾ Indeed, the negative perception of high fetal lactate levels likely arises due to the use of lactate as a downstream clinical biomarker of reduced fetal oxygenation in fetal distress. Together, this suggests that reduced delivery of oxygen to the placenta via impaired adaptation of the uterine circulation to pregnancy would have a far greater impact on fetal lactic acid concentrations than massage.

Concern: Massage in the first trimester damages the fetus or displaces the placenta. Two main concerns are raised; 1) never massage the abdomen^(11,12,15) as “applying abrupt pressure into the abdomen may increase the risk of miscarriage”;⁽¹¹⁾ and 2) deep pressure on lower back left side in the first trimester should be avoided “as this is where the placenta is situated and at this stage it is still developing and vulnerable” (p11),⁽¹²⁾ which implies that massage can damage the placenta. It is assumed that either a) the physical pressure from a massage on the lower back will provide a direct mechanical force to the uterus where it will damage or displace the placenta, or b) the deep pressure from the massage will press the abdomen, and thus the uterus, into the table when massaging the lower back of the prone client.

Scientific evidence and rationale: It is unclear how exactly massage will damage the placenta on the left side only as the embryo can implant and develop in any area of the uterus, which is located centrally in the pelvic cavity.⁽⁹⁶⁾ However, in the above scenarios the uterus and the fetus sit deep in the abdomen and are protected by the pubic bone, with the fetus further protected by the amniotic fluid.^(96,97) As such it would be difficult to connect with the uterus or fetus either via pressure from the massage table or via gentle abdominal massage techniques if abdominal massage was indicated and or desired. In a prone position, the sacrum provides bony protection from direct force from the pressure of a massage on the lower back.^(96,97)

Concern: Massage is a risk to fetal development in the first trimester. Many sources imply that massage is a risk for miscarriage with vague statements alluding to massage detrimentally impacting fetal development such as “the first trimester is the critical time when your baby’s major organs are developing”. Some health-care

professionals and massage therapists don’t recommend mothers ‘risk’ having a massage during this important period, implying or stating outright that massage can harm the development of the embryo and create a miscarriage or cause birth defects.⁽¹²⁾ An issue with these statements is that no explanation is given as how massage damages the fetus.

Scientific evidence and rationale: Notions of physical damage to the fetus that could affect organ development are addressed above. Normal fetal growth and organ development is regulated by the combination of adequate maternal nutrition, efficient fetal nutrient uptake via the placenta, and hormonal signalling in the fetal endocrine system (including the placenta).⁽⁹⁸⁾ It is unclear how massage could directly alter any of these pathways.

3. Aspects of the Massage Treatment in the First Trimester Initiating Contractions

Concern: Increased intrauterine pressure may increase the risk of miscarriage. A common statement made about massage in the first trimester is that it will increase intrauterine pressure, which is linked to an increased risk of miscarriage.⁽¹¹⁾ The explanation for this increased intrauterine pressure is due to the prone position where “because of gravity, the weight of the torso presses the prone client’s abdomen into the table or any additional supportive device”,^(3,15) and the pressure the massage therapist applies further increases intrauterine pressure.^(3,15) It is postulated that increases in intrauterine pressure irritate the uterine muscles (myometrium) which contract and, if done so with enough strength, cause premature contractions. It appears what that the authors are describing is extrauterine pressure from outside the uterus (e.g., the massage table, pillows) rather than intrauterine pressure (which refers to pressure inside the uterus stretching it outwards). We consider both intrauterine pressure and extrauterine pressure, as well as irritation of the uterine myometrium, below.

Concern: Massage will increase intrauterine pressure.

Scientific evidence and rationale: Intrauterine pressure increases over pregnancy as a result of the growing

placenta, amniotic sac, and fetus pushing out within the uterus, or during labour as a result of uterine contractions.⁽⁹⁹⁾ No research has investigated the prone position and massage. However, research on sleeping positions during pregnancy, and the prone position in medical settings for short periods of time, has not found the prone position unsafe, particularly in the first trimester when it remains comfortable.^(100,101)

Concern: Massage will increase extra-uterine pressure.

Scientific evidence and rationale: The pubic symphysis provides protection from extrauterine pressure until approximately 12 weeks of gestation where the tip of the uterus becomes large enough to be palpable just above the pubic symphysis.⁽⁹⁷⁾

Concern: Irritation of the myometrium (uterine smooth muscle). As well as extrauterine pressure irritating the uterine myometrium to stimulate contractions via massaging the abdomen,^(11-13,15) massage over the sacrum is also postulated to stimulate contractions.⁽¹³⁾

Scientific evidence and rationale: Uterine contractions are thought to be initiated by mechanical stretch (the tension on myometrial cells as the uterus distends), inflammatory mediators, and changes in placental estrogen production that align with fetal maturation.^(102,103) In the first half of pregnancy, the uterus remains comparatively small (expanding from a 10 mL non-pregnant cavity volume to a 1 L capacity by 20 weeks of gestation) compared to the second half of pregnancy where it stretches to hold 4.5 L by term.⁽¹⁰⁴⁾ Thus, it is extremely unlikely that lying prone in the first trimester, or small changes in extrauterine pressure from massage, will produce enough tension on, or 'irritation of', the myometrium to initiate contractions.

Concern: Massaging on or over specific pressure points/acupuncture points in the first trimester. This section refers to massaging over or on a pressure point/acupoint not the application of administering acupressure. It is frequently stated that deep pointed pressure and ischemic compression on near certain pressure points/acupuncture points should be avoided in the first trimester as they may

initiate contractions or potentially induce labour (Table 1).⁽¹⁴⁾ The explanation given is that "over-stimulation of these points is thought to cause the vagina to relax, the cervix to open, and the embryo to be discharged"^{(p9).}⁽¹²⁾

Scientific evidence and rationale: The mechanism of miscarriage and initiation of labour are slightly different. In miscarriage, fetal death leads to inflammation and the gestational sac is expelled from the body,⁽¹⁰⁵⁾ whereas the mechanism of initiation of labour involves a cascade of inflammatory mediators and changes in the uterine muscle cells to allow them to talk to each other and synchronise contractions.⁽¹⁰²⁾ Acupuncture is hypothesised to initiate the onset of labour at term as "acupuncture neuronal stimulation may increase uterine contractility either by central oxytocin release or by parasympathetic stimulation of the uterus".⁽¹⁰⁶⁾ The effectiveness of acupressure at term to stimulate uterine contractility to initiate labour has shown no evidence of benefit compared to sham controls⁽¹⁰⁷⁾ nor when compared to usual care.⁽¹⁰⁷⁾ The differing mechanisms between miscarriage and the initiation of labour and the lack of evidence of benefit for acupressure to initiate labour at term suggest that it is unlikely that massage of

TABLE 1. Acupoints Stated to be Avoided During a Massage in the First Trimester

<i>Acupoints to Avoid During the First Trimester</i>	<i>Location of the Acupoint on the Body</i>
Spleen 6 (SP6) ^(4,15,112)	inside distal medial aspect of the tibia
Spleen 10 (SP10) ⁽⁴⁾	medial proximal quadricep
Bladder 31 (BL31) ⁽¹¹²⁾	sacrum
Bladder 32 (BL32) ⁽¹¹²⁾	sacrum
Bladder 60 (BL60) ^(15,112)	lateral ankle
Bladder 61 (BL61) ⁽⁴⁾	lateral ankle
Bladder 67 (BL67) ^(4,15)	little toe
Gallbladder 21 (GB21) ^(4,112)	top of the shoulder
Large Intestine 4 (LI4) ^(4,112)	hand
Liver 3 (LR3) ^(4,15)	foot
Kidney 1 (K1) ⁽⁴⁾	bottom of foot
Kidney 3 (K13) ⁽¹⁵⁾	medial ankle
Kidney 5 (K15) ⁽⁴⁾	medial ankle

muscle tissue around or over an acupressure point in the first trimester will initiate the onset of labour.

Limitations

We can find no study that has specifically investigated the safety of massage during the first trimester using robust methodology. This paper is not determining the safety of massage during pregnancy, but rather uses scientific rationale to critically examine common statements about first trimester massage and miscarriage. This paper considers massage as administered by a trained professional massage therapist and does not include the use of massage devices such as massage guns. The paper focuses on massage and natural conception and does not address IVF or other medical fertility treatments where the rate of miscarriage can be slightly higher and where other physiological factors and mechanisms are involved.⁽¹⁰⁸⁾

CLOSING STATEMENT

Overall, whilst direct evidence from clinical trials is lacking, considerations of physiological mechanisms regulating pregnancy and known risk factors associated with miscarriage provide no evidence that massage in pregnancy would increase a patient's risk of miscarriage. Conversely, if a client perceives massage as relaxing, this could aid their mental health, in turn having positive effects on stress hormone levels. Pregnant people are often bombarded with information about what they can and cannot do, which can cause them considerable anxiety about being a 'good mother' and 'protecting their baby', and massage practitioners and health professionals should not further increase this emotional burden by making unsubstantiated claims about the risk of massage in pregnancy. Educational facilities who teach pregnancy massage should include this scientific rationale content when addressing massage and miscarriage.

CONFLICT OF INTEREST NOTIFICATION

Sarah Fogarty is a practicing massage therapist. The other authors declare no conflict of interest.

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REFERENCES

1. Kennedy AB, Cambron JA, Sharpe PA, Travillian RS, Saunders RP. Clarifying definitions for the massage therapy profession: the results of the Best Practices Symposium. *Int J Ther Massage Bodywork*. 2016;9(3):15–26.
2. Fogarty S, Steel A, Hall H, Hay P. Australian massage therapists' views and practices related to preconception, pregnancy and the early postpartum period. *Complement Ther Clin Pract*. 2020;40:101222.
3. Osborne C. *Pre- And Perinatal Massage Therapy: A Comprehensive Guide to Prenatal, Labor and Postpartum Practice*, 2nd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2012.
4. Stillerman E. *Prenatal Massage: A Textbook of Pregnancy, Labor, and Postpartum Bodywork*. New York City, NY: Mosby; 2008.
5. Yates S. *Pregnancy and Childbirth: A Holistic Approach to Massage and Bodywork*. Croydon, UK: Churchill Livingstone; 2010.
6. Stager L. *Nurturing Massage for Pregnancy. A Practical Guide to Bodywork for the Perinatal Cycle*. Burlington, MA: Jones & Bartlett Learning; 2010.
7. Waters B. *Massage During Pregnancy*, 3rd ed. Deming, NM: Bluewaters Press; 2003.
8. Morrison MR. *Massage for Pregnancy and Beyond*. Emeryville, CA: Rockridge Press; 2020.
9. Mathiesen GC. *The Essentials of Massage and Pregnancy*. Scotts Valley, CA: CreateSpace; ; 2016.
10. McCaulay PM. *Medical Massage Care's Pregnancy Massage*. Alexandria, VA: Phillip Martin McCaulay; 2022.
11. Estes M. The pregnant pelvis—an introduction to safe, effective prenatal massage therapy [online workshop by Carole Osborne]. Body Therapy Education [website]. 2016. Originally published in *Massage Magazine*, Summer 1998.
12. Shannon A. The whole nine months: massage in pregnancy. *Massage Australia*. 2010(66):4.
13. Cassar M-P. *Handbook of Clinical Massage: a Complete Guide for Students and Practitioners*, 2nd ed. Edinburgh: Elsevier; 2004.
14. Patel S. (2018, February 20). Is massage safe during pregnancy? UTSouthwestern Medical Blog. <https://utswmed.org/medblog/massage-pregnancy-guidelines/> Accessed 29 September, 2021.
15. Osborne C, Kolakowski M, Lobenstine DM. *Pre-and Perinatal Massage Therapy*, 3rd ed. UK: Hand-spring Publishing; 2021.

16. Fogarty S, McInerney C, Stuart C, Hay P. The side effects and mother or child related physical harm from massage during pregnancy and the postpartum period: an observational study. *Complement Ther Med*. 2019;42:89–94.
17. Mueller SM, Grunwald M. Effects, Side effects and contraindications of relaxation massage during pregnancy: a systematic review of randomized controlled trials. *J Clin Med*. 2021;10(16):3485.
18. Fogarty S, Barnett R, Hay P. Safety and pregnancy massage: a qualitative thematic analysis. *Int J Therapeut Massage Bodywrk*. 2020;13(1):4.
19. Hustin J, Jauniaux E, Schaaps JP. Histological study of the materno-embryonic interface in spontaneous abortion. *Placenta*. 1990;11(6):477–486.
20. Liddell HS, Pattison NS, Zanderigo A. Recurrent miscarriage—outcome after supportive care in early pregnancy. *Aust NZ J Obstet Gynaecol*. 1991;31(4):320–322.
21. San Lazaro Campillo I, Meaney S, Sheehan J, Rice R, O'Donoghue K. University students' awareness of causes and risk factors of miscarriage: a cross-sectional study. *BMC Women's Health*. 2018;18(1):188.
22. Kilshaw S, Omar N, Major S, Mohsen M, El Taher F, Al Tamimi H, et al. Causal explanations of miscarriage amongst Qataris. *BMC Pregnancy Childbirth*. 2017;17(1):250.
23. Bardos J, Hercz D, Friedenthal J, Missmer SA, Williams Z. A national survey on public perceptions of miscarriage. *Obstet Gynecol*. 2015;125(6):1313–1320.
24. World Health Organisation. *Spontaneous And Induced Abortion. Report of a WHO Scientific Group*. Meeting held in Geneva from 10–14 November 1969. 1970. Available from: <https://apps.who.int/iris/handle/10665/38211>
25. Centers for Disease Control and Prevention. *Stillbirth: What is Stillbirth?* CDC; 2020. <https://www.cdc.gov/ncbddd/stillbirth/facts.html>. Updated November 16, 2020. Accessed 22nd March, 2021.
26. Sands. Miscarriage. Surrey Hills, Australia; 2018. <http://www.sands.org.au/miscarriage>. Accessed 27 January, 2018.
27. Royal College of Obstetricians and Gynaecologists. Recurrent and late miscarriage: tests and treatments of couples [RCOG information brochure]. London, UK: RCOG; 2012.
28. Macklon NS, Geraedts JP, Fauser BC. Conception to ongoing pregnancy: the 'black box' of early pregnancy loss. *Hum Reprod Update*. 2002;8(4):333–343.
29. Giakoumelou S, Wheelhouse N, Cuschieri K, Entrican G, Howie SEM, Horne AW. The role of infection in miscarriage. *Hum Reprod Update*. 2016;22(1):116–133.
30. Balogun OO, da Silva Lopes K, Ota E, Takemoto Y, Rumbold A, Takegata M, et al. Vitamin supplementation for preventing miscarriage. *Cochrane Database Syst Rev*. 2016;2016(5):Cd004073.
31. Hure AJ, Powers JR, Mishra GD, Herbert DL, Byles JE, Loxton D. Miscarriage, preterm delivery, and stillbirth: large variations in rates within a cohort of Australian women. *PLOS ONE*. 2012;7(5):e37109.
32. Linnakaari R, Helle N, Mentula M, Bloigu A, Gissler M, Heilinheimo O, et al. Trends in the incidence, rate and treatment of miscarriage—nationwide register-study in Finland, 1998–2016. *Hum Reprod*. 2019;34(11):2120–2128.
33. Pinar MH, Gibbins K, He M, Kostadinov S, Silver R. Early pregnancy losses: review of nomenclature, histopathology, and possible etiologies. *Fetal Pediatr Pathol*. 2018;37(3):191–209.
34. Strumpf E, Lang A, Austin N, Derksen SA, Bolton JM, Brownell MD, et al. Prevalence and clinical, social, and health care predictors of miscarriage. *BMC Pregnancy Childbirth*. 2021;21(1):185.
35. Dimitriadis E, Menkhorst E, Saito S, Kutteh WH, Broens JJ. Recurrent pregnancy loss. *Nat Rev Dis Primers*. 2020;6(1):98.
36. Gruhn JR, Zielinska AP, Shukla V, Blanshard R, Capalbo A, Cimadomo D, et al. Chromosome errors in human eggs shape natural fertility over reproductive life span. *Science*. 2019;365(6460):1466–1469.
37. Forray A. Substance use during pregnancy. *F1000Res*. 2016;5.
38. Pineles BL, Park E, Samet JM. Systematic review and meta-analysis of miscarriage and maternal exposure to tobacco smoke during pregnancy. *Am J Epidemiol*. 2014;179(7):807–823.
39. Cozzolino M, García-Velasco JA, Meseguer M, Pellicer A, Bellver J. Female obesity increases the risk of miscarriage of euploid embryos. *Fertil Steril*. 2021;115(6):1495–1502.
40. Maconochie N, Doyle P, Prior S, Simmons R. Risk factors for first trimester miscarriage—results from a UK-population-based case-control study. *BJOG*. 2007;114(2):170–186.
41. Loos RJ, Yeo GS. The genetics of obesity: from discovery to biology. *Nat Rev Genet*. 2022;23(2):120–133.
42. Arck PC, Rütcke M, Rose M, Szekeres-Bartho J, Douglas AJ, Pritsch M, et al. Early risk factors for miscarriage: a prospective cohort study in pregnant women. *Reprod Biomed Online*. 2008;17(1):101–113.
43. San Lazaro Campillo I, Meaney S, Corcoran P, Spillane N, O'Donoghue K. Risk factors for miscarriage among women attending an early pregnancy assessment unit (EPAU): a prospective cohort study. *Irish J Med Sci*. 2019;188(3):903–912.
44. Milad MP, Klock SC, Moses S, Chatterton R. Stress and anxiety do not result in pregnancy wastage. *Hum Reprod*. 1998;13(8):2296–2300.
45. Nelson DB, Grisso JA, Joffe MM, Brensinger C, Shaw L, Datner E. Does stress influence early pregnancy loss? *Ann Epidemiol*. 2003;13(4):223–229.
46. Correa-de-Araujo R, Yoon SS. Clinical outcomes in high-risk pregnancies due to advanced maternal age. *J Womens Health*. 2021;30(2):160–167.

47. du Fossé NA, van der Hoorn M-LP, van Lith JM, le Cessie S, Lashley EE. Advanced paternal age is associated with an increased risk of spontaneous miscarriage: a systematic review and meta-analysis. *Hum Reprod Update*. 2020;26(5):650–669.
48. Zhang Y, Wang H, Pan X, Teng W, Shan Z. Patients with subclinical hypothyroidism before 20 weeks of pregnancy have a higher risk of miscarriage: a systematic review and meta-analysis. *PLoS One*. 2017;12(4):e0175708.
49. Tur-Torres MH, Garrido-Gimenez C, Alijotas-Reig J. Genetics of recurrent miscarriage and fetal loss. *Best Pract Res Clin Obstet Gynaecol*. 2017;42:11–25.
50. Garrido-Gimenez C, Alijotas-Reig J. Recurrent miscarriage: causes, evaluation and management. *Postgrad Med J*. 2015;91(1073):151–162.
51. Simón C, Rubio C, Vidal F, Gimenez C, Moreno C, Parrilla JJ, et al. Increased chromosome abnormalities in human preimplantation embryos after in-vitro fertilization in patients with recurrent miscarriage. *Reprod Fertil Dev*. 1998;10(1):87–92.
52. Weimar CH, Kavelaars A, Brosens JJ, Gellersen B, de Vreeden-Elbertse JM, Heijnen CJ, et al. Endometrial stromal cells of women with recurrent miscarriage fail to discriminate between high- and low-quality human embryos. *PLoS One*. 2012;7(7):e41424.
53. Hyde KJ, Schust DJ. Genetic considerations in recurrent pregnancy loss. *Cold Spring Harbor Perspect Med*. 2015;5(3):a023119.
54. Dimitriadis E, Menkhorst E, Saito S, Kutteh WH, Brosens JJ. Recurrent pregnancy loss. *Nat Rev Dis Primers*. 2020;6(1):98.
55. du Fossé NA, Lashley EE, Treurniet TT, van Lith JM, le Cessie S, Boosman H, et al. Exploring gender differences among couples with unexplained recurrent pregnancy loss regarding preferences for supportive care. *BMC Pregnancy Childbirth*. 2021;21(1):796.
56. Musters AM, Koot YE, van den Boogaard NM, Kaaijk E, Macklon NS, van der Veen F, et al. Supportive care for women with recurrent miscarriage: a survey to quantify women's preferences. *Hum Reprod*. 2013;28(2):398–405.
57. Musters AM, Taminiu-Bloem EF, van den Boogaard E, van der Veen F, Goddijn M. Supportive care for women with unexplained recurrent miscarriage: patients' perspectives. *Hum Reprod*. 2011;26(4):873–877.
58. Gulf Coast Acupuncture & Fertility. (2021 August; updated 2022 January 14). How a massage can inhibit your ability to get pregnant. Pensacola, FL: Gulf Coast Acupuncture & Fertility; 2021. Available from: <https://www.gulfcoastacupunctureandfertility.com/post/how-a-massage-can-inhibit-your-ability-to-get-pregnant>
59. Mayan Abdominal Massage For Trying to Conceive—Easy Self Fertility Massage That Helped Me Get Pregnant [blog post]. In: To make a mommy. How I got happy, healthy and pregnant! by Anna. Tomakeamommy.com, an Elite Cafemedia Family & Parenting Publisher; 2021. Available from: <https://www.tomakeamommy.com/mayan-abdominal-massage-for-fertility-easy-self-abdominal-massage-to-help-you-get-pregnant/>
60. James JL, Carter AM, Chamley LW. Human placentation from nidation to 5 weeks of gestation. Part I: What do we know about formative placental development following implantation? *Placenta*. 2012;33(5):327–334.
61. James JL, Chamley LW, Clark AR. Feeding your baby in utero: how the uteroplacental circulation impacts pregnancy. *Physiology*. 2017;32(3):234–245.
62. Allerkamp HH, Clark AR, Lee TC, Morgan TK, Burton GJ, James JL. Something old, something new: digital quantification of uterine vascular remodelling and trophoblast plugging in historical collections provides new insight into adaptation of the utero-placental circulation. *Hum Reprod*. 2021;36(3):571–586.
63. Burton GJ, Cindrova-Davies T, wa Yung H, Jauniaux E. Hypoxia and reproductive health: oxygen and development of the human placenta. *Reproduction*. 2021;161(1):F53–F65.
64. Burton GJ, Cindrova-Davies T, Turco MY. Review: Histotrophic nutrition and the placental-endometrial dialogue during human early pregnancy. *Placenta*. 2020;102:21–26.
65. Munk N, Symons B, Shang Y, Cheng R, Yu G. Non-invasively measuring the hemodynamic effects of massage on skeletal muscle: a novel hybrid near-infrared diffuse optical instrument. *J Bodyw Mov Ther*. 2012;16(1):22–28.
66. Skow RJ, Davenport MH, Mottola MF, Davies GA, Poitras VJ, Gray CE, et al. Effects of prenatal exercise on fetal heart rate, umbilical and uterine blood flow: a systematic review and meta-analysis. *Br J Sports Med*. 2019;53(2):124–133.
67. Latka M, Kline J, Hatch M. Exercise and spontaneous abortion of known karyotype. *Epidemiology*. 1999;10(1):73–75.
68. Russo LM, Whitcomb BW, Mumford SL, Hawkins M, Radin RG, Schliep KC, et al. A prospective study of physical activity and fecundability in women with a history of pregnancy loss. *Hum Reprod*. 2018;33(7):1291–1298.
69. de Andrade Ramos BR, Witkin SS. The influence of oxidative stress and autophagy cross regulation on pregnancy outcome. *Cell Stress Chaperones*. 2016;21(5):755–762.
70. James JL, Saghian R, Perwick R, Clark AR. Trophoblast plugs: impact on utero-placental haemodynamics and spiral artery remodelling. *Hum Reprod*. 2018;33(8):1430–1441.
71. Schaaps JP, Tsatsaris V, Goffin F, Brichant JF, Delbecq K, Tebache M, et al. Shunting the intervillous space: new concepts in human uteroplacental vascularization. *Am J Obstet Gynecol*. 2005;192(1):323–332.

72. Mercé LT, Barco MJ, Alcázar JL, Sabatel R, Troyano J. Intervillous and uteroplacental circulation in normal early pregnancy and early pregnancy loss assessed by 3-dimensional power Doppler angiography. *Am J Obstet Gynecol*. 2009;200(3):315.e1–315e8.
73. Clark AR, James JL, Stevenson GN, Collins SL. Understanding abnormal uterine artery Doppler waveforms: a novel computational model to explore potential causes within the utero-placental vasculature. *Placenta*. 2018;66:74–81.
74. Johnson MH. *Essential reproduction*, 8th edition. New York, NY: John Wiley & Sons Ltd; 2018.
75. Rathmell J, Fields H. Pain: pathophysiology and management. In: Longo D, Fauci A, Kasper D, Hauser S, Jameson J, Loscalzo J, eds. *Harrison's Principles of Internal Medicine, Vol. 1*, 18th edition. New York, NY: McGraw-Hill; 2012:93–101.
76. Magnus MC, Ferreira DDS, Borges MC, Tilling K, Lawlor DA, Fraser A. Cardiometabolic health during early adulthood and risk of miscarriage: a prospective study. *Wellcome Open Res*. 2020;5:205.
77. Nobles CJ, Mendola P, Mumford SL, Naimi AI, Yeung EH, Kim K, et al. Preconception blood pressure levels and reproductive outcomes in a prospective cohort of women attempting pregnancy. *Hypertension*. 2018;71(5):904–910.
78. Vincent K, Tracey I. Hormones and their interaction with the pain experience. *Rev Pain*. 2008;2(2):20–24.
79. Carvalho B, Angst MS, Fuller AJ, Lin E, Mathusamy AD, Riley ET. Experimental heat pain for detecting pregnancy-induced analgesia in humans. *Anesth Analg*. 2006;103(5):1283–1287.
80. Saanijoki T, Tuominen L, Tuulari JJ, Nummenmaa L, Arponen E, Kalliokoski K, et al. Opioid release after high-intensity interval training in healthy human subjects. *Neuropsychopharmacology*. 2018;43(2):246–254.
81. Prevost M, Zekowitz P, Tulandi T, Hayton B, Feeley N, Carter CS, et al. Oxytocin in pregnancy and the postpartum: relations to labor and its management. *Front Public Health*. 2014;2:1.
82. D'Anna-Hernandez KL, Ross RG, Natvig CL, Laudenslager ML. Hair cortisol levels as a retrospective marker of hypothalamic-pituitary axis activity throughout pregnancy: comparison to salivary cortisol. *Physiol Behav*. 2011;104(2):348–353.
83. Smith ID, Shearman RP. Fetal plasma steroids in relation to parturition: I. The effect of gestational age upon umbilical plasma corticosteroid levels following vaginal delivery. *BJOG*. 1974;81(1):11–15.
84. Ghaemmaghami P, Dainese SM, La Marca R, Zimmermann R, Ehlert U. The association between the acute psychobiological stress response in second trimester pregnant women, amniotic fluid glucocorticoids, and neonatal birth outcome. *Dev Psychobiol*. 2014;56(4):734–747.
85. Solano ME. Decidual immune cells: guardians of human pregnancies. *Best Pract Res Clin Obstet Gynaecol*. 2019;60:3–16.
86. Thurlby-Brook S. (2021, September 17) Is Massage Safe During Pregnancy? mumanu™. <https://mumanubalms.com/is-massage-safe-during-pregnancy/>. Updated 17 September. Accessed 29th September, 2021.
87. Crane JD, Ogborn DI, Cupido C, Melov S, Huggard A, Bourgeois JM, et al. Massage therapy attenuates inflammatory signaling after exercise-induced muscle damage. *Sci Transl Med*. 2012;4(119):119ra113.
88. Wiltshire EV, Poitras V, Pak M, Hong T, Rayner J, Tschakovsky ME. Massage impairs postexercise muscle blood flow and “lactic acid” removal. *Med Sci Sports Exerc*. 2010;42(6):1062–1071.
89. Moraska AF, Hickner RC, Rzasa-Lynn R, Shah JP, Hebert JR, Kohrt WM. Increase in lactate without change in nutritive blood flow or glucose at active trigger points following massage: a randomized clinical trial. *Arch Phys Med Rehabil*. 2018;99(11):2151–2159.
90. Illsley NP, Wootton R, Penfold P, Hall S, Duffy S. Lactate transfer across the perfused human placenta. *Placenta*. 1986;7(3):209–220.
91. Settle P, Mynett K, Speake P, Champion E, Doughty IM, Sibbly CP, et al. Polarized lactate transporter activity and expression in the syncytiotrophoblast of the term human placenta. *Placenta*. 2004;25(6):496–504.
92. Schneider H, Malek A, Duft R, Bersinger N. Evaluation of an in vitro perfusion system for the study of placental proteins: energy metabolism. In: Genbacev O, Klopper A, Beaconsfield R, eds. *Placenta as a Model and a Source*. New York: Plenum Press; 1989:39–50.
93. Ma LN, Huang XB, Muyayalo KP, Mor G, Liao AH. Lactic acid: a novel signaling molecule in early pregnancy? *Front Immunol*. 2020;11:279.
94. Suidan JS, Antoine C, Silverman F, Lustig ID, Wasserman JF, Young BK. Human maternal-fetal lactate relationships. *J Perinat Med*. 1984;12(4):211–218.
95. Schneider H. Placental oxygen consumption. Part II: In vitro studies—a review. *Placenta*. 2000;21:S38–S44.
96. McEvoy A, Tetrokalashvili M. *Anatomy, abdomen and pelvis, female pelvic cavity*. Treasure Island, FL: StatPearls Publishing; 2021. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK538435/>. Accessed 24th November 2021.
97. Naidu K, Fredlund K. *Gestational age assessment*. Treasure Island, FL: StatPearls Publishing; 2021. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK526000/>. Accessed 30 September 2021.
98. Murphy VE, Smith R, Giles WB, Clifton VL. Endocrine regulation of human fetal growth: the role of the mother, placenta, and fetus. *Endocr Rev*. 2006;27(2):141–169.

99. Rooijackers MJ, Rabotti C, Oei SG, Mischi M. Critical analysis of electrohysterographic methods for continuous monitoring of intrauterine pressure. *Math Biosci Eng.* 2020;17(4):3019–3039.
100. Silver RM, Hunter S, Reddy UM, Facco F, Gibbins KJ, Grobman WA, et al. Prospective evaluation of maternal sleep position through 30 weeks of gestation and adverse pregnancy outcomes. *Obstet Gynecol.* 2019;134(4):667–676.
101. Dennis AT, Hardy L, Leeton L. The prone position in healthy pregnant women and in women with preeclampsia—a pilot study. *BMC Pregnancy Childbirth.* 2018;18(1):445.
102. McEvoy A, Sabir S. Physiology, Pregnancy Contractions. Treasure Island, FL: StatPearls Publishing; 2021. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK532927/>
103. Young RC, Barendse P. Linking myometrial physiology to intrauterine pressure; how tissue-level contractions create uterine contractions of labor. *PLoS Comput Biol.* 2014;10(10):e1003850.
104. Geirsson RT. Intrauterine volume in pregnancy (MD thesis). University of Iceland, Reykjavik, Iceland. *Acta Obstet Gynecol Scand.* 1986;15(Suppl 136):1–74.
105. Larsen EC, Christiansen OB, Kolte AM, Macklon N. New insights into mechanisms behind miscarriage. *BMC Med.* 2013;11(1):154.
106. Tempfer C, Zeisler H, Heinzl H, Hefler L, Husslein P, Kainz C. Influence of acupuncture on maternal serum levels of interleukin-8, prostaglandin F2 α , and beta-endorphin: a matched pair study. *Obstet Gynecol.* 1998;92(2):245–248.
107. Smith CA, Armour M, Dahlen HG. Acupuncture or acupressure for induction of labour. *Cochrane Database System Rev.* 2017;10:CD002962.
108. Tummers P, Sutter PD, Dhont M. Risk of spontaneous abortion in singleton and twin pregnancies after IVF/ICSI. *Human Reprod.* 2003;18(8):1720–1723.
109. Hempstock J, Jauniaux E, Greenwold N, Burton GJ. The contribution of placental oxidative stress to early pregnancy failure. *Hum Pathol.* 2003;34(12):1265–1275.
110. Tong M, Viall CA, Chamley LW. Antiphospholipid antibodies and the placenta: a systematic review of their in vitro effects and modulation by treatment. *Hum Reprod Update.* 2015;21(1):97–118.
111. Xu J, Chen D, Duan X, Li L, Tang Y, Peng B. The association between antiphospholipid antibodies and late fetal loss: a systematic review and meta-analysis. *Acta Obstet Gynecol Scand.* 2019;98(12):1523–1533.
112. Massage & Myotherapy Australia [association website]. Pregnancy Massage: Guidelines. Melbourne, Australia: The Association; 2015. p. 1-5. Available from: <https://www.massagemyotherapy.com.au/Tenant/C0000012/00000003/PDF/Polices%20and%20Procedures/Pregnancy%20Massage%20-%20Guidelines%202018.pdf>

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