

Negative influence of maternal supine position in late pregnancy on maternal and fetal health

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SUMMARY

It is thought that the supine position in advanced pregnancy can increase the risk of stillbirth and threaten maternal health. The threats to the mother are relatively well known and concern disorders associated with inferior vena cava blood outflow, changes in cardiac activity and decreased blood pressure connected with aortocaval compression syndrome. The problem of threats to the fetus seems to be less obvious. The probable threat is in this case restricted blood flow through the uterine artery resulting in reduced oxygen availability and increased risk of fetal stress or intrauterine death. The conclusion is that pregnant women should be instructed to avoid sleeping or resting in the supine position and assume the left lateral position instead.

Key words: supine position; third trimester of pregnancy; fetal hypoxia; intrauterine death; pregnancy complications

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INTRODUCTION

The relationship of the maternal body position and hemodynamic changes in her organism as well as their consequences to the mother and fetus have been investigated for years. The left lateral position is believed to be the best for pregnant women, while the supine position is deemed to be the worst. Various publications from the 1990s confirmed the risk of unfavorable changes in the circulatory system of women in late pregnancy resting in the supine position. However, only further studies showed that these changes can have consequences to the fetus as well [1–3]. These disorders were described as two syndromes: inferior vena cava syndrome and aortocaval compression syndrome.

Inferior vena cava syndrome is a set of disorders caused by restricted blood flow through the inferior vena cava, which, in this case, results from the compression exerted by the pregnant uterus in the supine position. The severity and potential complications depend on individual anatomic features (primary diameter of the inferior vena cava), fetal weight, uterine volume and duration of compression. Short-term flow restriction does not usually entail any negative consequence, but prolonged compression may cause:

- restricted blood flow in the lower extremities with concomitant edema, which is the most severe in the feet and calves;
- dilatation of collateral veins in the lower extremities, abdomen and chest [4].

Aortocaval compression syndrome is caused by restricted flow through the abdominal aorta and inferior vena cava as a result of the uterus compressing these vessels when a woman rests in the supine position in late pregnancy. As in inferior vena cava syndrome, the severity of symptoms and potential complications are dependent upon the diameter of these vessels, fetal and uterine size, as well as duration of compression. Clinical symptoms in women are paleness,

excessive sweating, thready pulse, bradycardia, hypotonia and, in extreme cases, syncope [5].

Nevertheless, fetal consequences are the most dangerous. Lower blood pressure in the uterine artery results in reduced oxygen availability to the fetus, while prolonged hypoxemia exacerbates fetal stress and elicits a defensive reaction consisting in delivering oxygen to the central organs in the best way possible. Intrauterine fetal death can be an extreme consequence [11–13,17,18]. English literature states that aortocaval compression syndrome and inferior vena cava syndrome can cause so-called *supine hypotensive syndrome* [1,3]. In most cases, all symptoms subside upon switching to the left lateral position, but permanent defects in the maternal organism caused by prolonged disorders in the circulatory system described above prevent symptom regression. Moreover, these changes are repeatable, which means that assuming the supine position again causes a return of symptoms [1–3, 6–8].

The problem discussed herein becomes even more important when not only resting, but also sleeping in the supine position is considered. When sleeping, the position frequently does not change for many hours. If the supine position is the sleep position, one of the above-described syndromes may develop. High repeatability of this phenomenon may lead to permanent health impairment in both the mother and the fetus, including the most serious complication, i.e. intrauterine fetal death [9–13].

RELIABILITY OF ANALYZED SURVEY DATA

Most studies on this problem are survey-based investigations. Their credibility may be therefore doubted, as done by Warland J et al. [14]. These authors assessed the accuracy with which women reported their sleep positions. The study lasted for 3 nights and involved 30 women in late pregnancy who were instructed to try to sleep on the left side for as long in the night as possible, and to switch to their left if they woke up overnight in a different position. The entire study was registered with video cameras. Despite the fact that the women could answer the question about the time in the night spent on the left side relatively accurately, significant variability was observed between individual participants, which might have caused certain inaccuracies in studies on the influence of the sleep position on maternal and fetal health [14].

SLEEP POSITIONS OF WOMEN IN LATE PREGNANCY

O'Brien LM et al. [10] studied 51 pregnant women in order to describe their typical sleep positions and to determine the risk of complications associated with the supine position. Of all participants, 82.4% reported sleeping on their back for some part of night and the proportion of overall time spent in this sleep position was 26.5% [10]. This means that a considerable percentage of women may be at an increased risk of symptoms associated with aortocaval compression syndrome and inferior vena cava syndrome.

Maternal consequences of the supine position

Having analyzed statistical data and reported cases, it was concluded that the symptoms of the two syndromes can occur in women as early as in the 20th week of pregnancy [8].

It was confirmed that these symptoms mainly occur in the supine position and are practically non-existent when lying on the left side, which is believed to be optimal for pregnant women [1–3, 6–8]. Switching to the left is a simple way to improve both clinical state and comfort of pregnant women. The exact determination of which features might predispose to any of these syndromes has been unsuccessful, but associations have been found with uterine volume, fetal weight and, above all, maternal position [1,3,6,8]. These symptoms most commonly appear in primigravidas [11].

Moreover, a direct association was found between maternal position and the size of the inferior vena cava, also in women with no clinical symptoms, which might suggest that the syndrome may be of a mild course or does not occur in all women with decreased cross-section of the inferior vena cava. This may be a consequence of the presence of numerous collateral veins, which might compensate for inferior vena cava flow restriction for some time or for the entire pregnancy [1,2,7,15,16].

Aortocaval compression syndrome may have various severity grades: the symptoms can be mild, associated with slight circulation changes, or severe with considerable blood pressure falls, tachycardia and loss of consciousness [1–3,5,8,17]. The severity of these disorders is illustrated by an extreme case of a 41-year-old woman at week 39 of gestation, reported by De-Giorgio F et al. in 2012. The woman was

found dead in the supine position. Autopsy revealed that a probable cause of death was supine hypotensive syndrome, i.e. a disorder caused by aortocaval compression syndrome and compression of large abdominal blood vessels exerted by the uterus and the fetus [13]. Some sources report other causes of these symptoms, but most authors associate these circulation disorders mainly with the supine position [1–3,6–9,11–13,16–18]. Other potentially harmful positions are the lithotomy position and right lateral position [3].

Furthermore, bearing in mind the fact that the left lateral position is the most optimal for both the mother and the fetus, authors have also considered the problem of conducting certain studies in which women are placed in the supine position for a long time, e.g. cardiac imaging [8,16]. It must be underlined that the guidelines of the European Society of Cardiology (ESC) from 2011 on the diagnostic and therapeutic management of pregnant women with cardiac conditions state that echocardiography is the basic diagnostic examination to be conducted in pregnant women (class IC). This examination is not associated with radiation exposure, it is readily available and can be repeated, if necessary [19,20]. It is conducted in the left lateral position (a typical position for cardiac ECHO), which helps eliminate negative changes in ejection volume and cardiac output. If the examination requires patients to be placed in the supine position, its duration should be shortened as much as possible [19,20].

It has been shown that the heart changes its activity and size considerably with a changed position. These changes reach several to over thirty per cent and are greater in later pregnancies (starting from week 20). This has led to a suspicion that women in later pregnancy than week 20 should be placed in the left lateral position for studies such as magnetic resonance imaging, since the load on the cardiovascular system in the supine position is too great and distorts the image [8].

Fetal consequences of the supine position

Older publications state that even if uterine artery flow is reduced in the supine position due to compression of large abdominal vessels by the uterus, this does not necessarily entail changes in fetal circulation [2,15]. According to other sources, however, there is no certainty concerning the quality of transport between the

uterine artery and placenta in the conditions of lower blood pressure despite the lack of changes in the fetal umbilical artery. This might suggest that the fetus receives lower amounts of substances essential for its survival, e.g. oxygen [6,7,17,18]. The identification of the factor that would increase fetal stress in the maternal supine position is even more difficult since, as shown in studies, maternal blood parameters, such as hemoglobin saturation, partial pressure of oxygen and carbon dioxide, bicarbonate content and pH, are completely independent of the maternal position and are maintained on a stable level irrespective of position changes [21]: pH 7.46, arterial P_{CO_2} 26.6 mmHg, venous P_{O_2} 88.3 mmHg, bicarbonates 18.2 mEq/L, and hemoglobin oxygen saturation 0.96.

Moreover, the thesis that sleep apnea or hypopnea might cause fetal disorders was refuted since studies on sleep in pregnant women did not show any significant associations between these respiration disorders and maternal partial pressure of oxygen in arterial blood [22]. The two studies mentioned above suggest that the problem does not lie in maternal blood parameters, including oxygenation, but rather in the mother-to-fetus transport of these substances [6,7,11,17,21,22]. The relationship between the supine position and fetal stress seems to be unquestionable as research demonstrates that the supine position maintained for a long time gradually decreases fetal heart rate and blood pH. This fetal behavior was described by Abitbol MM in 14% of women, of whom 19% presented symptoms only in the supine position. The symptoms regressed immediately after switching to the side and returned once the women turned on her back again [17]. This occurred concurrently with uterine artery contraction, decreased flow in the femoral arteries and reduced pulse of the big toe. These signs indicate aortocaval compression syndrome [17].

In a retrospective survey-based study conducted in 583 patients experiencing stillbirth, Rådestad I et al. asked the women about the position taken when settling to sleep and the position in which they were lying when waking up 4 weeks, a week and the night preceding stillbirth [9]. The study showed that in all 3 tested time periods, significantly more women woke up than went to sleep in the supine position, and over 25% of women woke up in the supine position the night preceding stillbirth, which might indicate that this sleep position is a risk factor of fetal death [9].

By contrast with older data, a study by Khatib N et al. from 2014 indicates that the umbilical artery blood flow coefficient decreases significantly when lying in the supine position in late pregnancy (36–40 weeks) [7]. This difference may result from the fetal age of children whose mothers participated in given studies. According to the authors, flow restriction triggers a defense reaction typical of hypoxemia with the aim to provide all substances essential for survival to the brain at the expense of the rest of the organism. In this study, the middle cerebral artery was observed. Despite the protective mechanisms, flow in this artery was significantly reduced whenever the mother assumed the supine position. The authors claim that the cause of this phenomenon in late pregnancy is aortocaval compression syndrome [7].

Another study, carried out by Silva KP et al. in 2016, failed to show significant differences in blood flow through the umbilical vessels, while blood flow in the middle cerebral artery returned to the values registered in the maternal left lateral position ten minutes after having been initially reduced [18]. This might be interpreted as an effective brain sparing mechanism, but cannot be confirmed without further investigation [18]. Moreover, the cause of differing results concerning umbilical artery blood flow remains unknown. Perhaps this results from yet unknown factors or too small groups of patients enrolled into these studies.

In a case-control study with a large sample (395 pregnant patients) from 2015, Gordon A et al. [11] compared different potential risk factors between women experiencing stillbirth and women with no detected abnormalities. The factors that differentiated the two groups included [11]: level of education (lower in the stillbirth group), well-paid job (less frequently in the stillbirth group), suspicion of fetal growth abnormalities (much more frequently in the stillbirth group) and supine sleep position (much more frequently in the stillbirth group). These data might lead to a conclusion that supine sleep position may increase the risk of stillbirth and should be viewed as one of risk factors [9,11,12].

In a paper from 2017 prepared by the Maternal Sleep In Pregnancy Research Group from the University of Auckland, cardiotocography was conducted in 29 healthy women in late pregnancy [6]. State 1F, i.e. low fetal activity, was predominant in patients sleeping in the supine position. In addition, fetal heart rate was also lower in this position. State 4F, i.e. the

most active, energetic fetal movements, was the most common in the left lateral position. Moderate movement (state 2F) was the most common in the semi-recumbent position. These data lead to a conclusion that, in the maternal supine position, the fetus prepares for temporary hypoxia by decreased mobility and redirection of blood supply from the peripheral to central parts [6,23].

Another article, published in 2017 by Warland J et al., distinguishes 3 factors that need further investigation in terms of a possible risk of stillbirth, namely [12]: fetal mobility, maternal sleep position and maternal diet. The authors suggest that sudden increased fetal mobility might be a warning sign of a direct threat to fetal life. Maternal posture, particularly sleeping in the supine position, is believed to be a significant risk factor [6,11,12,23]. As for the maternal diet, it is indicated to introduce probiotics in order to reduce the risk of stillbirth [12].

CONCLUSION

Having analyzed the available articles on the influence of the maternal position on the health of herself and her child, it can be concluded that around week 20 of gestation women should be instructed to try to take the left lateral position when sleeping and resting, and to avoid the supine position whenever possible [1–3,8,6–13,15–18]. Nevertheless, there is no definitive and clear evidence that the supine position always restricts blood flow in the uterine or umbilical artery, or that such restriction has a negative effect on maternal and fetal well-being [6,7,15,17,18]. Available statistical data lead to a conclusion that the maternal supine position correlates with both maternal and fetal disorders in a number of studies [1–3,6–8,11,13,16–18]. Maternal symptoms include [1–5,8,13,16]: restricted blood flow in the lower extremities, restricted blood flow through the uterine artery, blood pressure fall, changes in cardiac activity and functional parameters, and syncope. Fetal symptoms encompass [2,3,6,7,11–13,17,18]: lower fetal mobility, lower heart rate, probable activation of physiological hypoxemia-related central organ sparing mechanisms, and a possible increase in the risk of stillbirth.

Since there is some statistical evidence to associate these maternal and fetal symptoms with the maternal supine position, the risk of these disorders, including stillbirth, should be

reduced by educating women about these correlations even though the knowledge about mechanisms underlying these symptoms is lacking. There are no statistically significant data on negative effects of the left lateral position. Taking this position might reduce the risk of health-related consequences in a dozen or several dozen per cent of women [9,10] who could eliminate this risk factor if properly instructed.

The problem still remains open and requires further studies in order to elucidate the mechanism in which the supine position might lead to intrauterine death, and to determine maternal and fetal characteristics that would include these patients in the group of an increased risk of consequences associated with staying in the supine position for a long time in late pregnancy.

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