Original scientific article/Izvirni znanstveni članek

Effects of maternal abdominal decompression on umbilical artery and fetal middle cerebral artery blood flow

Vpliv abdominalne dekompresije pri materi na pretok krvi v umbilikalni arteriji in plodovi srednji možganski arteriji

Sara Mugerli, Gordana Njenjić, Vesna Fabjan Vodušek, Miha Lučovnik

Key words: antenatal classes; Doppler ultrasound; resistance index; intrauterine growth restriction

Ključne besede: šola za starše; dopplerski ultrazvok; rezistenčni indeks; zastoj v rasti

Sara Mugerli, M.D.; Nova Gorica General hospital, Ulica padlih borcev 13a, 5290 Šempeter pri Gorici

Kontaktni e-naslov/ Correspondence e-mail: sara.mugerli@gmail.com

Gordana Njenjić, Graduate midwife; University Medical Centre Ljubljana, Division of Gynaecology and Obstetrics, Šlajmerjeva ulica 3, 1000 Ljubljana

Vesna Fabjan Vodušek, M.D.; University Medical Centre Ljubljana, Division of Gynaecology and Obstetrics, Šlajmerjeva ulica 3, 1000 Ljubljana

Assistant Professor, Miha Lučovnik, M.D., PhD; University Medical Centre Ljubljana, Division of Gynaecology and Obstetrics Šlajmerjeva ulica 3, 1000 Ljubljana

ABSTRACT

Introduction: Maternal abdominal decompression during pregnancy could be used in an attempt to improve utero-placental blood flow. We utilized Doppler ultrasonography to investigate the effects of this procedure on blood flow in the umbilical artery and fetal middle cerebral artery.
Methods: Women (n = 23) with singleton pregnancies attending antenatal abdominal decompression were enrolled in the study. Doppler velocity waveforms were obtained from umbilical artery and fetal middle cerebral artery before and after a 30-minute decompression session. Resistance indices were compared using the Student′s t - test ($p < 0.05$ significant).
Results: 23 healthy pregnant women were included at an average gestational age of 36^{+1} weeks. The mean resistance index before decompression in the umbilical artery was 0.58 (s = 0.10) and after decompression 0.54 (s = 0.07, p = 0.06). In the middle cerebral artery the values were 0.72 (s = 0.11) and 0.77 (s = 0.08), respectively (p = 0.01).
Discussion and conclusion: Significantly increased resistance index in the middle cerebral artery implies a higher fetal brain oxygenation after decompression. This is further corroborated by the trend towards a decrease in umbilical artery resistance index. The effects of decompression could be beneficial in pregnancies complicated by IUGR or hypertensive disorders of pregnancy.

IZVLEČEK

Uvod: Abdominalna dekompresija v nosečnosti bi se lahko uporabljala za izboljšanje pretoka krvi v uteroplacentarnem žilju. Z dopplerskim ultrazvokom se je spremljal vpliv te metode na pretok krvi v umbilikalni arteriji in plodovi srednji možganski arteriji.
Metode: V študijo smo vključili nosečnice (n = 23) z enoplodnimi nosečnostmi, ki so se udeležile abdominalne dekompresije. Z dopplerskim ultrazvokom smo izmerili pretoke v umbilikalni arteriji in srednji možganski arteriji pri plodu pred dekompresijo in neposredno po njej. Primerjali smo rezistenčne indekse, za kar smo uporabili Studentov t-test. Za statistično značilno smo vzeli vrednost p < 0,05.
Rezultati: Vključili smo 23 nosečnic s povprečno gestacijsko starostjo 36^{+1} tednov. Povprečni rezistenčni indeks v umbilikalni arteriji pred dekompresijo je bil 0,58 (s = 0.10), po dekompresiji pa 0,54 (s = 0,07, p = 0,06). V srednji možganski arteriji je znašal 0,72 (s = 0,11) pred dekompresijo in 0,77 (s = 0,08) po dekompresiji (p = 0,01).
Diskusija in zaključek: Upor v srednji možganski arteriji je bil po dekompresiji statistično značilno višji, kar kaže na boljšo oksigenacijo plodovih možganov. To dodatno podkrepi trend zniževanja upora v umbilikalni arteriji. Ugotovljene spremembe po dekompresiji bi bile lahko koristne v nosečnosti, kjer je prisoten zastoj v rasti ali ob hipertenzivnih boleznih v nosečnosti.

Received/Prejeto: 24. 4. 2015
Accepted/Sprejeto: 10. 9. 2015

http://dx.doi.org/10.14528/snr.2015.49.3.61

Introduction

The method abdominal decompression was developed in the 1960s. An airtight frame is placed at a pregnant woman's abdomen and subsequently decompressed to -50 to -100 mmHg for 15 to 30 seconds per minute for 30 minutes. It was initially employed with uterine contractions in order to relieve pain during childbirth. Its antepartum use was based on few poorly controlled studies showing a possible "pumping" of blood through intervillous space resulting in an apparent improvement in fetal wellbeing (Hofmeyr & Kulier, 2012). Better designed, prospective studies in low risk pregnancies did not show any effect of decompression on preeclampsia, intrauterine growth restriction (IUGR), perinatal mortality, Apgar scores, and childhood development (Liddicoat, 1968; Coxon, et al., 1973). The effects of decompression on fetal circulation per se have not as yet been adequately studied and all of the studies were conducted decades ago, before the routine use of Doppler ultrasound as an antenatal diagnostic tool. After that, the studying of decompression stopped and there is no new data or evidence supporting its use in low-risk or high-risk pregnancies. This is why we decided to conduct a study that would objectively evaluate the changes caused by decompression.

It is possible to objectively and accurately evaluate changes in fetal circulation by using the Doppler ultrasound. Doppler blood flow waveforms in the umbilical artery and the middle cerebral artery of the fetus are routinely measured when screening for and diagnosing disorders of fetal tissue perfusion, e.g. IUGR (Deane, 2002). In a normal pregnancy, the impedance to flow in umbilical artery decreases throughout the second half of pregnancy and up to the 42nd week (Joern, et al., 1996; Acharya, et al., 2005). On the other hand, with a hypoxemic intrauterine environment in pregnancies complicated by IUGR and/or preeclampsia, there is a progressive increase in impedance to flow in the umbilical artery (Trudinger, et al., 1985; Reuwer, et al., 1987; Todros, et al., 1999). Impedance to flow in the middle cerebral artery is normally high. In fetal hypoxemia, however, there is a fall of resistance to blood flow in the middle cerebral artery. This is caused by a redistribution of tissue perfusion, favoring central nervous system on the account of kidneys, gastrointestinal tract and lower extremities (the so-called brain sparing theory) (Nicolaides, 2002).

Our objective was to test the hypothesis that abdominal decompression improves fetal perfusion and oxygenation. For this purpose we analyzed changes in umbilical artery and middle cerebral artery Doppler velocity waveforms which could be associated with decompression.

Methods

Due to practical limitations it was impossible to design a blinded trial. We therefore used an interrupted time series design, obtaining our measures before and after decompression.

Description of the research instrument

We chose resistance index (RI) as the index of change in blood flow waveform in the studied fetal arteries. RI represents a ratio between (PSV-ED) and ED, PSV being peak systolic velocity and ED end diastolic flow and it is routinely used to quantify the waveform dynamics (Deane, 2002).

Description of the sample

Women with singleton low-risk pregnancies attending abdominal decompression as a part of their pre-birth classes at our institution were enrolled in the study conducted from September through October 2013. All participants provided a written informed consent. The study protocol was approved by the National Medical Ethics Committee, decree No°158/09/13. Twenty three consecutive pregnant women attending decompression were enrolled in the study, 14 (61 %) nulliparous and 9 (39 %) multiparous. The mean maternal age was 34 years (range 26 to 42 years), and the mean body mass index was 26 kg/m^2 (range 21.5 kg/m^{2}to 35.3kg/m^2). All women were enrolled in the third trimester (mean gestational age 36^{+1} weeks, range 34^{+1} to 40^{+6} weeks). None of the pregnancies were complicated by IUGR or preeclampsia, and none of the women enrolled smoked during pregnancy.

Description of the research procedures and data analysis

Blood flow in the umbilical artery and in the middle cerebral artery was measured by Doppler ultrasonography before a 30-minute decompression session. The measurements were then repeated within 15 minutes from the end of decompression. All measurements were performed on women in supine position by two board certified perinatologists.

We used the Student's t - test to compare RIs in the umbilical artery and the middle cerebral artery before and after decompression. We used the Statistical Package for the Social Sciences (SPSS software), version 18, Chicago, IL, USA. Statistical relevance was set at p values under 0.05.

Results

The average RI in the umbilical artery before decompression was 0.58 (s = 0.10) and 0.54 (s = 0.07)

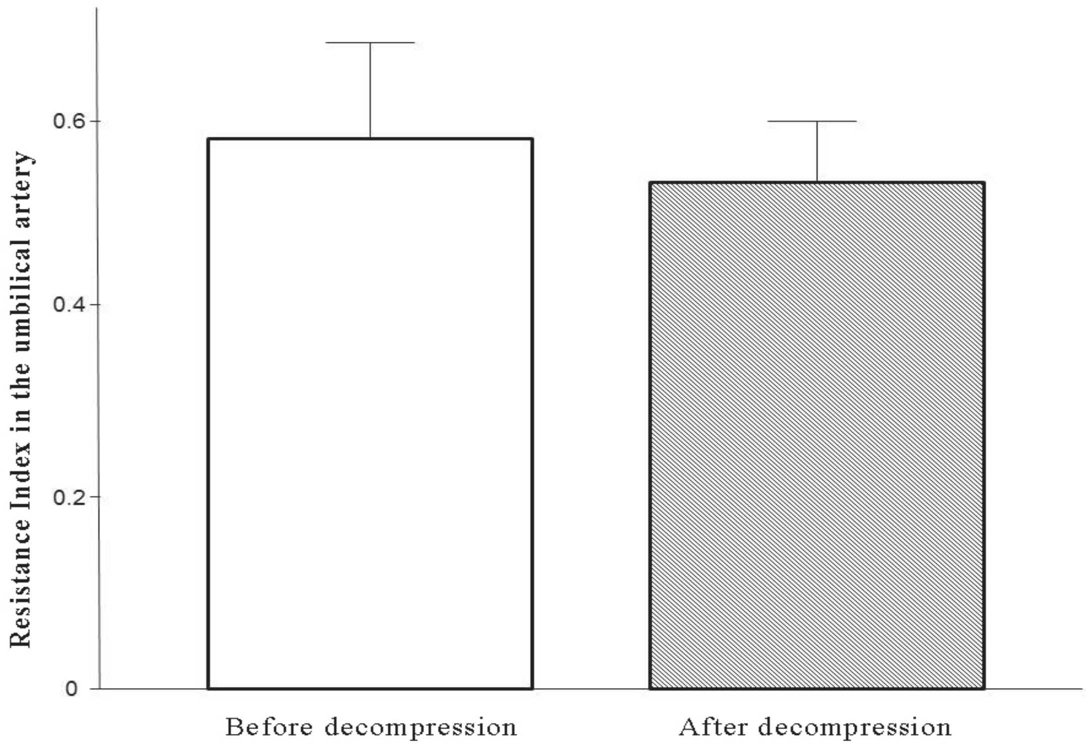

Figure 1: *Resistance index in the umbilical artery before and after decompression*
Slika 1: *Rezistenčni indeks v umbilikalni arteriji pred in po dekompresiji*

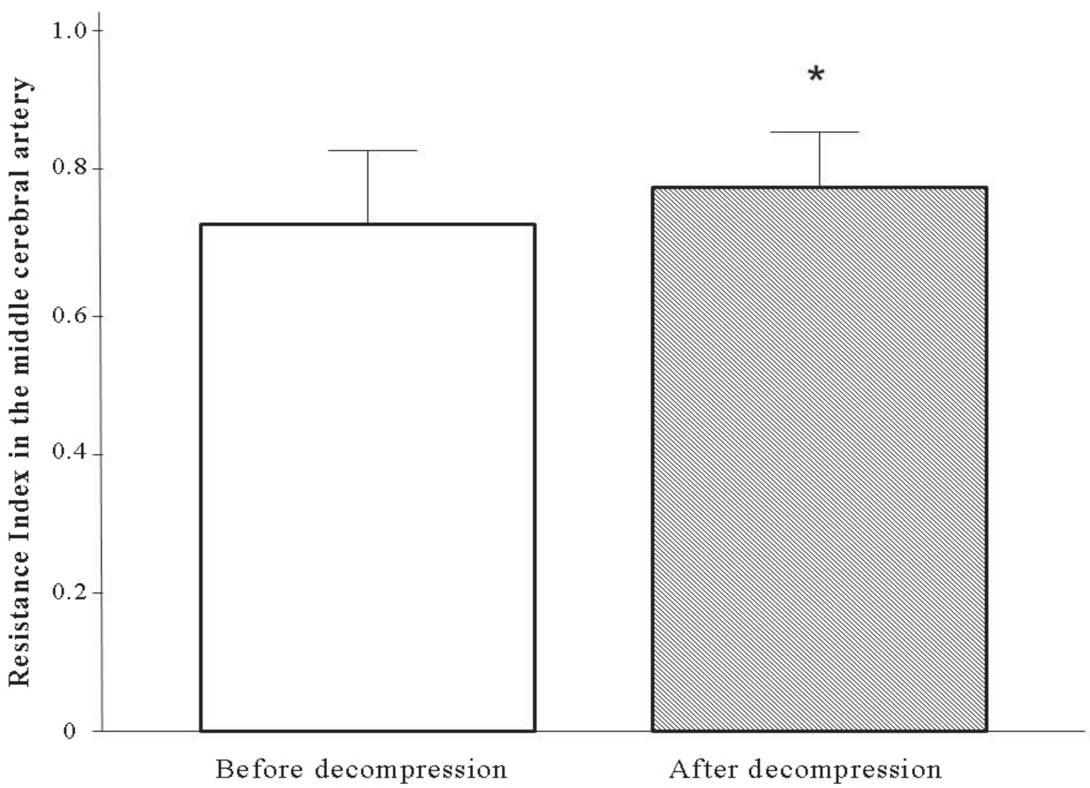

Figure 2: *Resistance index in the middle cerebral artery before and after decompression*
Slika 2: *Rezistenčni indeks v srednji možganski arteriji pred in po dekompresiji*

after decompression ($p = 0.06$). In the middle cerebral artery the values were 0.72 ($s = 0.11$) and 0.77 ($s = 0.08$), respectively ($p = 0.01$).

The difference between mean RIs in the umbilical artery is displayed in Figure 1 whereas Figure 2 presents the change in RI in the mean cerebral artery. Means and standard deviations are shown, $p = 0.06$.

Means and standard deviations are shown, the asterics (*) represents statistical significance ($p = 0.01$).

Discussion

Our study shows that abdominal decompression alters the patterns of blood flow in the fetal circulation. We found a trend towards a reduction in umbilical artery RI after decompression, although it did not reach statistical significance. Moreover, middle cerebral artery RI increased significantly after decompression, implying less brain sparing effect due to better fetal brain oxygenation associated with decompressing the maternal abdomen.

Effects of abdominal decompression on blood flow in the fetus have not yet been directly studied. Mathews and Loeffler (1968) found a slight, although statistically non-significant increase in scalp blood pH after 20 contractions with abdominal decompression during labour. Our results could be interpreted as being in accordance with these findings since they indicate a change in placental perfusion towards a better oxygenation of fetal tissues. On the other hand, studies performed in the 1960s and 1970s showed no decrease in incidence of IUGR and adverse perinatal outcomes with decompression (Liddicoat, 1968; Coxon, et al., 1973). These studies focused on prevention of these complications in low-risk pregnancies. According to our data, changes in fetal blood flow achieved by decompression are not considerable, and the apparent decrease in umbilical artery RI did not reach statistical significance. Therefore, the lack of benefit of decompression for prevention of IUGR is not surprising. Further studies are needed, however, to determine whether increased perfusion achieved by decompression could be beneficial in pregnancies in which complications are already present, e.g. preventing premature birth complications in cases of IUGR or late preterm hypertensive disorders of pregnancy.

The main weakness of our study is the small sample size. Even with only 23 women included, however, we showed a statistically significant change in middle cerebral artery blood flow suggesting better oxygenation of fetal brain. This finding is further reinforced by the opposite changes in RI within the umbilical artery, implying less resistance to flow in the utero-placental unit after decompression. Further randomized studies with larger sample sizes and a control group that would not undergo abdominal decompression are needed to reject or confirm our findings. In addition, studies include a series of measurements in order to estimate the effects of decompression at different gestational ages.

Conclusion

We were able to show that abdominal decompression alters the patterns of blood flow in the uteroplacental circulation. It is up for further research and serial measurements of blood flow in relation to decompression to determine whether it could benefit the women with high-risk pregnancies and if it could impact the neurodevelopment of the fetuses studied.

Literatura

Acharya, G., Wilsgaard, T., Berntsen, G.K., Maltau, J.M. & Kiserud, T., 2005. Doppler-derived umbilical artery absolute velocities and their relationship to fetoplacental volume blood flow: a longitudinal study. *Ultrasound in obstetrics & gynecology*, 25(5), pp. 444–453.
http://dx.doi.org/10.1002/uog.1880
PMid:15816007

Coxon, A., Fairweather, D.V., Smyth, C.N., Frankenberg, J. & Vessey, M., 1973. A randomised double blind clinical trial of abdominal decompression for the prevention of pre-eclampsia. *Journal of Obstetrics and Gynaecology of the British Commonwealth*, 80(12), pp. 1081-1085.
http://dx.doi.org/10.1111/j.1471-0528.1973.tb02983.x
PMid:4586680

Deane, C., 2002. Doppler ultrasound: principles and practice. In: Nicolaides, K., Rizzo, G., Hecher, K. & Ximenes, R. eds. *Doppler in Obstetrics.* London: The Fetal Medicine Foundation, pp. 4–24.

Hofmeyr, G.J. & Kulier, R., 2012. Abdominal decompression in normal pregnancy. *Cochrane Database Syst Rev*, 6, p. CD001062.
http://dx.doi.org/10.1002/14651858.CD001062.pub2
PMid:22696321

Joern, H., Funk, A., Goetz, M., Kuehlwein, H., Klein, A. & Fendel, H., 1996. Development of quantitative Doppler indices for uteroplacental and fetal blood flow during the third trimester. *Ultrasound in medicine and biology*, 22(7), pp. 823–835.
http://dx.doi.org/10.1016/0301-5629(96)00090-7
PMid:8923702

Liddicoat, R., 1968. The effects of maternal antenatal decompression on infant mental development. *South African Medical Journal,* 42(9), pp. 203–211.

Mathews, D.D. & Loeffler, F.E., 1968. The effect of abdominal decompression on fetal oxygenation during pregnancy and early labour. *Journal of Obstetrics and Gynaecology of the British Commonwealth*, 75(3), pp. 268–270.
http://dx.doi.org/10.1111/j.1471-0528.1968.tb02076.x
PMid:5642474

Nicolaides, K., 2002. Doppler studies in fetal hypoxemic hypoxia. In: Nicolaides, K., Rizzo, G., Hecher, K. & Ximenes, R. eds. *Doppler in Obstetrics*. London: The Fetal Medicine Foundation, pp. 62–77.

Reuwer, P.J., Sijmons, E.A., Rietman, G.W., van Tiel, M.W. & Bruinse, H.W., 1987. Intrauterine growth retardation: prediction of perinatal distress by Doppler ultrasound. *Lancet*, 2(8556), pp. 415-418.
http://dx.doi.org/10.1016/S0140-6736(87)90956-1
PMid:2887724

Todros, T., Sciarrone, A., Piccoli, E., Guiot, C., Kaufmann, P. & Kingdom, J., 1999. Umbilical Doppler waveforms and placental villous angiogenesis in pregnancies complicated by fetal growth restriction. *Obstetrics* & *Gynecology*, 93(4), pp. 499–503.
http://dx.doi.org/10.1016/S0029-7844(98)00440-2
PMid:10214822

Trudinger, B.J., Giles, W.B., Cook, C.M., Bombardieri, J. & Collins, L., 1985. Fetal umbilical artery flow velocity waveforms and placental resistance: clinical significance. *British Journal of Obstetrics and Gynaecology*, 92(1), pp. 23–30.
http://dx.doi.org/10.1111/j.1471-0528.1985.tb01044.x
PMid:4038455

Cite as/Citirajte kot:
Mugerli, S., Njenjić, G., Fabjan Vodušek, V. & Lučovnik, M., 2015. Effects of maternal abdominal decompression on umbilical artery and fetal middle cerebral artery blood flow. Obzornik zdravstvene nege, 49(3), pp. 190–194.
http://dx.doi.org/10.14528/snr.2015.49.3.61