CASE REPORT:

Hypervolemia and physiology changes in triplet pregnancy in a mother with permanent pacemakers due to bradicardia resulting from sinus node dysfunction due to AV block with secondary infertility for 19 years

Ali Sungkar, Fita Maulina*, M Adya F Dilmy
Department of Obstetrics and Gynecology Faculty of Medicine, University of Indonesia, General Hospital Cipto Mangunkusumo, Jakarta, Indonesia

ABSTRACT

The well-known hypervolemia associated with normal pregnancy averages 40 to 45 percent above blood volume in non-pregnant women after 32 to 34 weeks. The case was on Mrs. FN, 40 years old, a patient reffered due to sinus bradycardia before the insertion of permanent pacemaker. After 6 month-use of the permanent pacemaker, she became pregnant with triplet pregnancy. This case report evaluated the patient's condition from her hypervolemic condition to her cardiac function.

Keywords: Pacemaker; hypovolemia; haemodynamic adaptation; triplet pregnancy

ABSTRAK

Hipervolemia yang diketahui terkait dengan kehamilan normal rata-rata memiliki volume darah 40 hingga 45 persen daripada tidak hamil setelah 32 hingga 34 minggu. Artikel ini membahas kasus pada Ibu FN, 40 tahun, seorang pasien yang dirujuk karena pemasangan alat pacu jantung permanen pre sinus bradikardia. Setelah 6 bulan menggunakan alat pacu jantung pasien hamil dengan kehamilan triplet, laporan kasus ini melaporkan evaluasi kondisi pasien dari hipervolemia hingga fungsi jantung.

Kata kunci: Alat pacu jantung; hipervolemia; adaptasi hemodinamik; kehamilan triplet

***Correspondence:** Fita Maulina*, Department of Obstetrics and Gynecology Faculty of Medicine University of Indonesia General Hospital Cipto Mangunkusumo, Jakarta, Indonesia. E-mail: maulinafieta@gmail.com

pISSN:0854-0381 ● eISSN: 2598-1013 ● doi: http://dx.doi.org/10.20473/mog.V28I32020.128-134
● Maj Obs Gin. 2020;28:128-134 ● Received 1 Aug 2019 ● Accepted 7 Feb 2020

INTRODUCTION

Pregnancy-induced hypervolemia has several important functions. First, it meets the metabolic demands of the enlarged uterus and its greatly hypertrophied vascular system. Second, it provides abundant nutrients and elements to support the rapidly growing placenta and fetus. Increased intravascular volume also protects the mother, and, in turn, the fetus against deleterious effects of impaired venous return in supine and erect positions. Lastly, it safeguards the mother against adverse effects of parturition-associated blood loss. Despite the increasing use of permanent cardiac pacemakers, there are little data related to pregnancy. Normal physiologic alterations of pregnancy need to be taken into account in the management of pregnant woman with pacemaker in place. We present a case of a patient with a preexisting pacemaker who presented in pregnancy in order to illustrate pertinent issues in this regard.[1,2,5,7,9]

CASE REPORT

The case was on Mrs. FN, 40 years-old patient reffered by a doctor from a cardiology hospital in Jakarta due to sinus bradycardia pro permanent pacemaker insertion. The patient said she always felt exhausted, and having chest pain since a month before admission. Her heart rate was never up to 50 x/m, usually in 19-35 x/m, but the patient preferred to routinely visiting a cardiology clinic than accepted PPM insertion to solve her complaints. Her complaints worsened every time she walks. The patient said she felt as if her chest were downtrodden with a big stone, spreading to her back. She fell unconscious twice, and fainted when she got the attack. The doctor said her complaint corresponded to symptomatic bradycardia on sinus node dysfunction and advices her to have PPM insertion immediately.

After 6 months of using inserted PPM, she went back to the hospital due to pregnancy, and checked for her pacemaker function to her cardiologist and the result was that she could continue her pregnancy but still had to make visits every month. The patient was referred by her cardiologist to obstetrics and gynecology department. The patient had her first examination and ultrasound in the clinic, assessed as G2P1, with triplet pregnancy. The three fetuses were alive, dichorionic triamniotic. The patient had inseretion of permanent pacemaker due to bradycardia resulting from sinus node dysfunction because of arterioventricular block, with secondary infertility for 19 years. This patient was presented for prenatal care in the first trimester of pregnancy. She had a significant past medical history of bradycardia, hypotension and syncope that required permanent DDD cardiac pacemaker due to sinus node dysfunction. The patient had already applied double-chamber permanent pacemaker with threshold 0.5 mV (PPM setting 60x/m). Her heart rate was already 60x/m. The patient went to obstetric clinic reffered by cardiology division, due to pregnancy with post PPM SA node dysfunction (HR 19x/m). Obstetric ultrasound showed a fetus with no morphological abnormalities and normal movements. The uterus was anteflexed, enlarged in size. Three gestational sacs, including yolk sac in every sac, were observed. Cardiotocography showed a normal pattern. She was consulted to cardiology departement due to pregnancy tolerance.

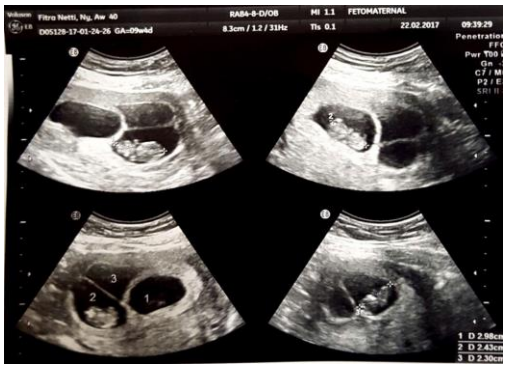

Figure 1. Ultrasound examination to dichorionic diamniotic triplet pregnancy

Table 1. Laboratory results in whole trimesters

Trimester	Laboratory result
I	Hemoglobin 13.6
	Haematocrit 38.5
	Leucocyte 11.8
	Thrombocyte 266000
	MCV 88.5/MCH 31,3/MCHC 35.3
II	Haemoglobin 11.1
	Haemotocrit 31.8
	Leucocyte 12.270
	Thrombocyt 266000/
	MCV 90.1/MCH 31,4/MCHC 34.9
III	Haemoglobin 10.9
	Haemotocrit 32.7
	Leucocyte 12980
	Thrombocyte 171000
	MCV 83.0/ MCH 27.7/ MCHC 33.3

Examination of the patient's pregnancy revealed hypervolemia associated with normal pregnancy. Pre-pregnancy pacemaker settings were established during her pregnancy. Pacemaker examination showed that the pacemaker was programmed in DDD mode with a low rate of 60 ppm. She had predominantly atrial pacing at 60 ppm with native AV conduction and ventricular sensing. The patient underwent primary cesarean section at 35 weeks gestation with delivery of a healthy triplet infants with fetal birth weight of the 1st baby girl of 1400 grams, the 2nd baby girl of 1100 gram (monochorionic diamniotic placentae), and 3rd baby

boy of 1600 grams (single placentae). Preoperative anesthesia and cardiologist consultation was obtained.

Hypervolemia as physiologic condition occurs in pregnancy which has have several important functions in view of multiple pregnancy that was experienced by the patient. Permanent pacemaker is well tolerated in pregnancy. All patients should, however, be closely monitored during and after pregnancy.

DISCUSSION

The haemodynamic changes begin early in the first trimester. The plasma volume starts increasing in the sixth week of pregnancy and approaches 50% above baseline till the end of second trimester. It then tends to plateau until delivery.[3] As compared to plasma volume there is slightly lesser rise in red cell mass, which results in the relative anaemia of pregnancy. The heart rate increases to reach a level about 20% above baseline to facilitate the increase in cardiac output. With placental growth, uterine blood flow increases and there is a fall in the peripheral resistance. This may result in a slight fall in blood pressure, which also begins in the first trimester. The haemodynamic changes of a normal pregnancy lead to an increase in cardiac output, which begins in the first trimester and approaches 30–50% above baseline by the end of the second trimester.[1-3]

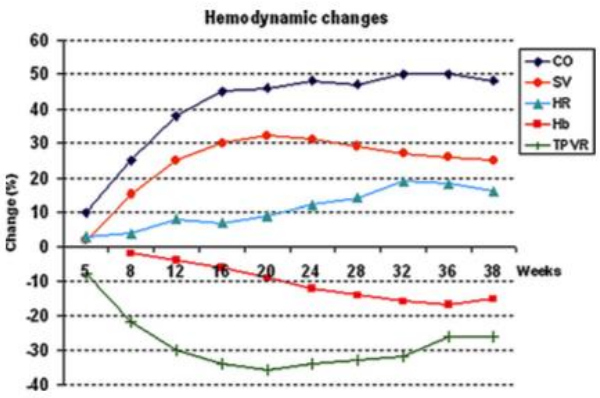

Figure 2. Haemodynamic changes in pregnancy[1]

During pregnancy, the total blood volume increases by about 1.5 liters, mainly to supply the demands of the new vascular bed and to compensate for blood loss occurring at delivery. Of this, around one liter of blood is contained within the uterus and maternal blood spaces of the placenta. Increase in blood volume is, therefore, more marked in multiple pregnancies and in iron deficient states. Expansion of plasma volume occurs by 10–15% at 6–12 weeks of gestation. During pregnancy, plasma renin activity tends to increase and atrial natriuretic peptide levels tend to reduce, though slightly. This suggests that, in pregnant state, the elevation in plasma volume is in response to an underfilled vascular system resulting from systemic vasodilatation and increase in vascular capacitance.[1,8,14]

Major hemodynamic changes take place during pregnancy. Total peripheral vascular resistance (TPVR) is reduced and blood volume and cardiac output are increased around 50%.[2] During labor and delivery, cardiac output is further increased as a result of uterine contractions and maternal effort. After delivery, most changes are rapidly reversed in the first 2 weeks with further normalization toward preconception values after 3–12 months.[1,2]

Pregnancy induces a series of haemostatic changes, with an increase in concentration of coagulation factors, fibrinogen, and platelet adhesiveness, as well as diminished fibrinolysis, which lead to hypercoagulability and an increased risk of thromboembolic events. In addition, obstruction to venous return by the enlarging uterus causes stasis and a further rise in risk of thromboembolism.[2]

Because of great plasma augmentation, hemoglobin concentration and hematocrit decrease slightly during pregnancy. As a result, whole blood viscosity decreases. Hemoglobin concentration at term averages 12.5 g/dL, and in approximately 5 percent of women, it is below 11.0 g/dL. Thus, a hemoglobin concentration below 11.0 g/dL, especially late in pregnancy, should be considered abnormal and usually due to iron deficiency rather than pregnancy hypervolemia.[2,7,10]

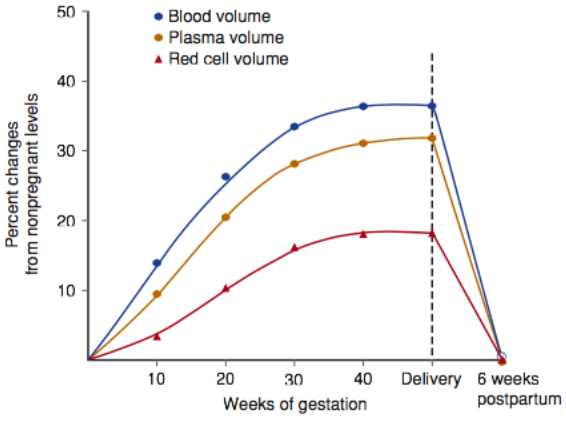

Figure 3. Changes in total blood volume and its components.[1]

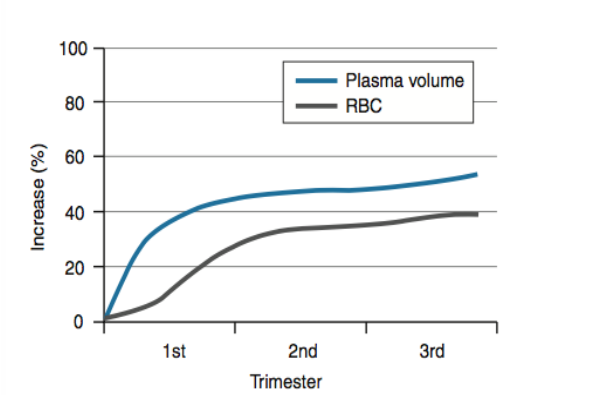

Figure 4. Plasma volume and red blood cell (RBC) during pregnancy.[3]

Haemodilution in pregnancy was first described as average drop in haematocrit of 5 U for a singleton and 7 U for a twin pregnancy during the second trimester. This is a consequence of the intravascular volume expansion, which starts at 8–10 weeks and reaches a maximum during the second trimester as described above. The lower limit for haemoglobin concentration in non- pregnant women is about 11.5–12g/dL. The British Committee for Standards in Haematology considers anaemia to be present in a pregnant woman when the levels drop less than 110 g/L in the first trimester, less than 105 g/L in the second and third trimesters and less than 100 g/L in the postnatal period or if the haematocrit drops below 30%.[2,8,13,14]

The difference in timing between the increase in red blood cell mass and plasma volume expansion result in physiologic fall in hematocrit in the first trimester despite adequate iron stores (Physiologic or dilutional anemia of pregnancy), which persists until the end of the second trimester. The number of erythrocytes increases approximately 25% in comparison to singleton pregnancy.[20]

Cardiac output is increased as early as the fifth week and reflects a reduced systemic vascular resistance and an increased heart rate. Compared with prepregnancy measurements, brachial systolic blood pressure, diastolic blood pressure, and central systolic blood pressure are all significantly lower 6 to 7 weeks from the last menstrual period The resting pulse rate increases approximately 10 beats/min during pregnancy. Between weeks 10 and 20, plasma volume expansion begins, and preload is increased.[3]

Atrioventricular Block (AVB) during pregnancy is a rare disease that a disorder of the cardiac conduction system. AVB could be asymptomatic. It is typical of permanent bradycardia and may cause to weakness, dizziness, dyspnea, syncope or heartfailure. Patient with AVB must evaluate with somenon-invasive techniques such as transthoracic echocardiography, treadmill test, and holter monitorization because of determining the prognosis of the disease. The reareno established guidelines for clinical management of the AVB in pregnancy. Although it is asymptomatic if a patient with AVB has complaints such as recurrent syncope and heartfailure, permanent pacemaker recommend. In ourcase, we presented pregnant women with AVB that was not need a permanent pacemaker.[17-19]

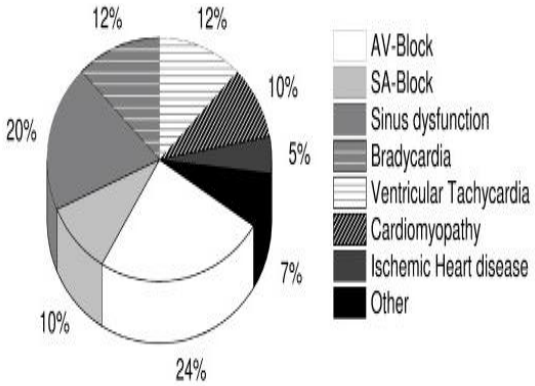

Figure 5. Indication of patient using pacemaker.[4]

Little change was seen in the major indications for PPMs across the study period; high-level atrioventricular block (HLB; 3o, Mobitz type II and other 2o blocks) was the most frequent major indication across the study period, although falling from 41% of cases in 1995–1999 to 33% for 2005–2009. Bundle branch block (BBB) and sick sinus syndrome (SSS) remained around 12% of cases each, while atrial fibrillation increased from 12% to 16%. There were 232 postablation (surgical, radiofrequency or cryoablation) cases. There was little difference between men and women in the indications for a PPM; women were somewhat more likely to be diagnosed with SSS (16% vs 11%, $p<0.001$) and less likely to have either HLB or BBB block (45% vs 51%, $p<0.001$).[14]

Although the cells of the SA node set the pace of the heartbeat, the AV node and the purkinje fibers possess unstable resting membrane potensial and hence; can act as pacemaker under certain conditions. However, since these various autorhythmic cells have different rates at which they slowly depolarize to threshold, the rates at which they naturally generate action potensials also differs considerably.[9]

The SA node is the normal pacemaker of the heart because it contains the myocardial autorhytmic cells

with the fastest rate of generating action potensials. Other potensial pacemakers process autorhythmic cells that normaly fire at rhytm slower than that of the SA node and consequently, they are unable to set the heartbeat.

The Purkinje fibers fire action potensials spontaneously at a slower rate, between 20 and 40 beats per minute. The AV node, for example, are capable of spontaneously firing action potensials, however their firing rate is very slow, between 40 and 60 beats per minute. The SA node, on the other hand, fires at a higher rate between 70 and 80 beats per minute. The SA node, on the other hand, fires at higher rate between 70 and 80 beats per minute.[9]

The increased cardiac output and slight decrease in BP during pregnancy is associated with a marked reduction in systemic vascular resistance. Total peripheral resistance decreases very early during pregnancy and continues to decrease throughout the second and third trimester, although to a lesser extent near term. Arterial compliance also changes dramatically during pregnancy. Arterial compliance increases during the first trimester and remains elevated throughout the remainder of pregnancy. Thus, both steady and pulsatile afterload decreases occur during normal pregnancy in humans.[8,9,14]

While the mechanisms responsible for mediating the changes in systemic hemodynamics have yet to be completely elucidated, a number of important factors are thought to contribute to physiological changes in the vascular system that occur during pregnancy. Substantial evidence indicates that nitric oxide (NO) production is elevated in normal pregnancy and that these increases appear to play an important role in the vasodilation of pregnancy.

Hormonal factors such as estrogen and relaxin are thought to be important in stimulating the production of NO during pregnancy. Relaxin, which is primarily produced by the corpus luteum, has been shown to chronically reduce total peripheral resistance and increase cardiac output and systemic arterial compliance.

Management during pregnancy

Usually patients with pacemakers tolerate the pregnancy well. The few reported maternal complications appeared to be isolated to patients with underlying structural heart disease. reported their experience with 11 pregnant patients with pacemakers. Three of these patients, who had underlying structural heart disease, developed maternal complications. One patient developed cardiac decompensation in the third trimester and was induced at 38 weeks. The other developed recurrent palpitations secondary to a short run of atrial fibrillation. Both these patients had uneventful deliveries and postpartum courses. The third patient developed progressive right ventricular failure and had an intrauterine fetal death at 20 weeks gestation. Although these data suggest the need for more careful surveillance when a structural heart defect is associated with pace-maker usage, given the very limited nature of these reported events, a firm recommendation cannot be established.

With regard to routine care, comanagement with the cardiology service is required. Either before the pregnancy or early in the first trimester, an EKG, echocardiogram and baseline pacemaker interrogation should be done. Device interrogation can provide information about pacemaker dependency. Pacemaker dependent patients may have no or very slow escape rhythms and require extra precautions during surgery. Throughout the pregnancy, attention should be paid to any new onset of symptoms such as palpitations, shortness of breath, syncope, seizure-like activity, dizziness, confusion, and exercise intolerance. Our patient began experiencing light-headedness and breathlessness with exertion, in the early second trimester. After cardiac evaluation the rate settings of the pacemaker were increased with resolution of the patient's symptoms

Red cell mass (driven by an increase in maternal erythropoietin production) also increases, but relatively less, compared with the increase in plasma volume, the net result being a dip in hemoglobin concentration. Thus, there is dilutional anemia. The drop in hemoglobin is typically by 1–2 g/dL by the late second trimester and stabilizes thereafter in the third trimester, when there is a reduction in maternal plasma volume (owing to an increase in levels of atrial natriuretic peptide).[1,6.9]

The red blood cell indices change little in pregnancy. However, there is a small increase in mean corpuscular volume (MCV), of an average of 4 fl in an iron-replete woman, which reaches a maximum at 30–35 weeks gestation and does not suggest any deficiency of vitamins B12 and folate. Increased production of RBCs to meet the demands of pregnancy, reasonably explains why there is an increased MCV (due to a higher proportion of young RBCs which are larger in size). However, MCV does not change significantly during pregnancy and a hemoglobin concentration <9.5 g/dL in association with a mean corpuscular volume <84 fl probably indicates co-existent iron deficiency or some other pathology.

During labour and delivery

The haemodynamic changes during labour and delivery are sudden. Upto 500 mL of blood is released into the circulation with each uterine contraction, prompting a rapid increase in cardiac output and blood pressure. The cardiac output is often 50% above baseline during the second stage of labour and may be even higher at the time of delivery. During labour, every uterine contraction injects about 300–500 ml of blood from the uteroplacental circulation. Simultaneously, during the second stage of labour, maternal pushing decreases the venous return to the heart, causing a decrease in cardiac output. These sudden and frequent variations in cardiac output during the second stage of labour may turn to be critical for some women with underlying heart disease, or for women who had pacemaker due to any cardiac problems because we have to adjust the heart rate

Post pregnancy, plasma volume decreases as a result of diuresis, and the blood volume returns to non-pregnant values. Hemoglobin and hematocrit increase consequently. Plasma volume increases again two to five days later, possibly because of a rise in aldosterone secretion. Later, it again decreases. Significant elevation has been documented between measurements of hemoglobin taken at 6–8 weeks postpartum and those taken at 4–6 months postpartum, indicating that it takes at least 4–6 months post pregnancy, to restore the physiological dip in hemoglobin to the non-pregnant values.

CONCLUSION

Pregnancy in patients with pacemakers is possible but requires a multidisciplinary approach to care. Normal physiologic changes in pregnancy may necessitate antenatal pacing rate adjustments. It may be difficult to distinguish between common pregnancy symptoms and mild degrees of cardiac dysfunction. Other than routine thromboprophylaxis, no other anticoagulation is needed. Pacemaker dependency should be recognized early in pregnancy. Despite cesarean delivery in this case, route of delivery is generally based on obstetric indications. During surgery, bipolar electrocautery should be used to reduce electromagnetic interference and the grounding pad should be placed as far away from the pacemaker as possible. Following the pregnancy, it should be anticipated that the patient would return to her baseline cardiac status and therefore have the pacemaker settings adjusted accordingly.

REFERENCES

1. Pillay PS, Piercy CN, Tolppanen H, Mebazaa A. Physiological changes in pregnancy. Cardiovascular Journal of Africa. 2016;27(2).
2. Cunningham FG, Leveno KJ, Bloom SL, et al. Maternal Physiology. Williams Obstetrics. 24th ed. 2014; p. 55-8.
3. Cornette J, Ruys TPE, Rossi A, et al. Hemodynamic adaptation to pregnancy in women with structural heart disease. International Journal of Cardiology. Elsevier, 2013;825-31.
4. Haarmark C, Kanters JK, Mehlsen J. Tilt table testing of patient with pacemaker and recurrent syncope. Elsevier. Oct 2015.
5. Bhide A, Arulkumaran S, Damania KR, Daftary SN. Physiological changes is pregnancy. Haematological disorders and red-cell alloimmunization in pregnancy. Arias practical guide to high tisk pregnancy and delivery. 4th edn.
6. Thaman R, Curtis S, Faganello G, et al. Cardiac outcome of pregnancy in women with a pacemaker and women with untreated atrioventricular conduction block. Europace. 2011;13:859-63.
7. Zagrosek VR, Borghi C, Cifkova R, et al. ESC Guidelines on the management of cardiovascular diseases during pregnancy. ESC guidelines. European Heart Journal. 2011;32:3147-97.
8. Chandra S, Tripathi AK, Mishra S, et al. Physiological changes in hematological parameters during pregnancy. Indian J Hematol Blood Transfus. 2012;28(3):144-6.
9. Hall ME, George EM, Granger JP. The Heart During Pregnancy. Rev Esp Cardiol 2011 November; 64(11): 1045-1050
10. Cornette J, Rossi A, Rizopoulos D, et al. Haemodynamic adaptation to the pregnancy in a women with structural heart disease. International Journal of Cardiology. 2012
11. Ray P, Murphy GJ, Shutt LE. Recognition and management of maternal cardiac disease in pregnancy. British Journal of Anesthesia. 2004; 428-39.
12. Grover S, Sheth P, Haines DE, et al. Management of cardiac pacemakers in a pregnant patient. Journal of Obstetrics and Gynecology, 2015;5:60-9.
13. Taylor DJ, Lind T. Red cell mass during and after normal pregnancy. Br J Obstet Gynaecol. 1979; 86(5):364-70.
14. Ramsay M. Normal hematological changes during pregnancy and the puerperium. In: Pavord S, Hunt B, editors. The obstetric hematology manual. Cambridge: Cambridge University Press; 2010. p. 1–11
15. Bradshaw PJ, Stobie P, Knuiman MW, et al. Trends in the incidence and prevalence of cardiac

pacemaker insertions in an ageing population. Open Heart. 2014;1:e000177. doi:10.1136/openhrt-2014-000177
16. Esper RB, Holanda R, Taraasoutchi F, et al. Permanent pacemaker implantation in a pregnanct woman with rheumatic mitral valve disease. Arq. Bras. Cardiol. 2009;92(5):e59-e62. ISSN 1678-4170. doi: https://doi.org/10.1590/S0066-782X2009000500017.
17. Sharma J, Malhotra M, Pundir P. Successful pregnancy outcome with a cardiac pacemaker after complete heart block. Int J Gynecol Obstet. 2000; 68:145-6.
18. Dalvi B, Chaudhuri A, Kulkarni HL, Kale PA. Therapeutic guidelines for congenital complete heart block are presenting in pregnancy. Obstet Gynecol. 1992;79: 802-4.
19. Kivrak T, Kivrak V, Kivrak YY, Karaca I. Presenting of pregnant woman with atrioventricular block. SM J Case Rep. 2017;3(5):1058.
20. Dera A, Grzegorz H. Breborowicz, Keith L. Twin pregnancy- physiology, complications and the mode of delivery. Archives of Perinatal Medicine. 2017;13(3):7-16.