International Journal of Engineering Trends and Technology
ISSN: 2231 – 5381 /doi:10.14445/22315381/IJETT-V69I6P227

Volume 69 Issue 6, 182-192, June, 2021
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Descriptive Study Of Antepartum Fetal Monitoring In High Andean Zones, Cerro De Pasco During January – February 2020

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Abstract — *This quantitative exploratory study shows the behavior of antepartum electronic fetal monitoring NST in pregnant women attended at the Daniel Alcides Carrion Hospital at Cerro de Pasco in January and February 2020. Methodology: It is an observational, descriptive, prospective, cross-sectional study in 155 pregnant women. The technique used was cardiotocographic analysis with the FISHER test, and descriptive statistics were used through Microsoft office Excel 2010 spreadsheet. Results: antepartum monitoring elements were presented on average as follows: Baseline 134 beats, variability 10 beats, accelerations and fetal movements 6 and 8 during 30 minutes respectively; most of the tests are in normal conditions, baseline was found from 100 to 160 beats, variability from 4 to 15 beats, a slight decrease in acceleration is observed at higher altitude, movements behaved similarly throughout the altitude. Conclusions: The elements of antepartum fetal monitoring - NST, are within normal parameters, according to the FISHER test, this could be due to the adaptation of the fetal pulmonary vessels, however, there is slight decrease in acceleration at higher altitude, suggestive of high altitude hypoxia; further investigation is recommended.*

Keywords — *antepartum, cardiotocographic, fetal, monitoring, non-stressed.*

I. INTRODUCTION

Modern obstetrics is concerned with maternal health and intrauterine patient, at first the trend was to prioritize the mother because the technologies were not accessible to all, then in 1880 the first phonocardiograph was invented, afterwards, Einthoven developed the fetal echocardiography, being introduced by Hofbauer and Weiss in 1908 and after 45 years they managed to make their first recorded analysis of fetal heartbeats with artifacts coming from the maternal side (gastric sounds, heartbeat among others). Later they worked to clean up these sounds and in 1866 Hammache popularized the use of the fetal ECG [1].

Parallel to all the above mentioned event, Bishop was the one who used the ultrasonic Doppler effect for the automated monitoring of the fetal heartbeat in 1968 [1]. In fact there is data and evidence that the concern of evaluating the patient inside the womb dates back to 1650, in a French province, and there was a doctor known as Marsac who was even ridiculed for telling his experience of having listened to "buzzing in the abdomen of a pregnant patient" [2].

Currently for continuous recording of the fetal heartbeat, the electronic fetal monitor is used, which is found in second level facilities and in facilities that perform Basic Obstetric and Neonatal Functions (known as FONB by its initials in spanish hospitals as the present case study), corresponding to the first level. However, another important factor is to know the physiology and adaptations to high altitude, since it decreases the availability and uptake of oxygen, which may have effects on the parameters of the fetal heart rate, which could lead to an erroneous diagnosis of hypoxia due to placental cause.

II. PROBLEM STATEMENT

Electronic fetal monitoring is a process of continuous recording of the fetal heartbeat, which allows us an exhaustive analysis of it in order to detect hypoxia early and prevent asphyxia. Depending on when it is performed, it can be antepartum when it is done during pregnancy and intrapartum during labor.

The aforementioned actions are aimed at safeguarding the integrity of the CNS of the fetus, which ensures the preservation of all the capabilities of the child and to ensure its subsequent development.

On the other hand, it is important to consider the environmental context in the high Andean zones as the inhabitants of the Pasco Region, who live above 3000 meters above sea level, have an anatomy and physiology adapted to respond to the inclemency of high altitudes, as well as to the effects that the open-pit mining center could have. Such conditions also compromise fetal development; to fulfill the reproductive process some adaptations are produced to respond to the requirements of the reproductive process e.g. the placenta is larger, the circulating volume and the globular components do the same, to compensate for the need of oxygen for the fetus, as there are changes in the fetal maternal circulation, the fetal heart rate elements are significantly affected.

The internal environment (meaning the mother) must also be considered, since almost everything that happens to the mother with respect to the basic functions will have repercussions on the fetus since the mother is the vehicle of communication between the environment and the fetus.

The behavior of fetal heart rate elements at high altitudes and maternal characteristics has been little reviewed; hence the importance of the present investigation, and the usefulness of these results for future in-depth research.

The objective of this study is to determine the behavior of electronic fetal antepartum monitoring - NST in pregnant women attended at the Daniel Alcides Carrion Hospital in Cerro de Pasco from January to February 2020. This will be done by identifying the behavior of the elements of antepartum fetal monitoring - NST, according to the FISHER test by altitude of residence of the pregnant women in the Hospital Daniel Alcides Carrion de Cerro de Pasco 2020 by analyzing the behavior of the baseline in relation to the altitude of residence of the pregnant women, the behavior of variability in relation to the altitude of residence of the pregnant women, the behavior of acceleration in relation to the altitude of residence of the pregnant women and the behavior of fetal movements in relation to the altitude of residence of the pregnant women.

Intrauterine patient care requires equipment that can give us real-time indications. In this sense, technology has definitely advanced, although it is not perfect, its correct use and accurate interpretation contributes to give society human beings with all their capabilities.

In order to achieve the proposed objectives, it is necessary to know the physiological behavior of the fetal heart rate at high altitude, a parameter that indicates the fetal state.

These results will contribute to a more objective interpretation of cardiotocographic tracings and will be a valuable input for future research.

III. LITERATURE REVIEW

Bahrum [3], in the article “Combining intermittent auscultation and contraction palpation monitoring with cardiotocography in inpartu mothers” describes the accuracy of combining intermittent auscultation and contraction palpation monitoring with cardiotocography. This study was performed on 36 mothers in labor chosen by purposive sampling technique, descriptive analysis was done with chi square test (goodness of fit). The accuracy of the combination of intermittent auscultation and monitoring of contraction palpation with cardiotocography is significant ($p = 0.000$, $<\alpha = 0.05$). They concluded that monitoring combined with both aspects during labor contributes to the prevention of fetal distress.

Valdivia [4], in their thesis "Efficacy of antepartum electronic monitoring in the diagnosis of fetal distress - Perinatal National Maternal Institute - 2013", established the efficacy of antepartum electronic monitoring for the diagnosis of distress, based on the Apgar and characteristics of the amniotic fluid. It was an observational study, with analytical and retrospective design, in which 346 pregnant women participated who underwent antepartum electronic fetal monitoring with and without diagnosis of fetal distress who attended the Fetal Medicine Unit of the Perinatal National Maternal Institute during the year 2013. Reaching the following results: The findings of the electronic fetal monitoring were normal baseline (86.8%), decreased variability (15%), late decelerations (5.8%) and variable decelerations (3. 3%), observed decelerations < 7 points were: sensitivity 74%, specificity 72%, positive predictive value 13% and negative predictive value 98%; according to Apgar at 5 minutes < 7 points were: sensitivity 69%, specificity 71%, positive diagnostic predictive value 9% and negative predictive value 98%; according to abnormal amniotic fluid were: sensitivity 31%, specificity 70%, positive diagnostic predictive value 23% and negative predictive value 78%. The conclusions obtained were that positive antepartum electronic monitoring for diagnosis of fetal distress is effective in establishing an Apgar less than 7; likewise, negative electronic fetal monitoring for diagnosis of fetal distress is effective in establishing an Apgar greater than or equal to 7.

Medina [5], in the article "Antepartum fetal monitoring in the high-risk unit of Hospital San Ignacio" published the results of a study of 259 tests, 205 NST tests and 54 PTC tests, performed in 162 high-risk patients, the preponderant pathologies were: hypertensive disorders 55% (N:89). There were 71.2% (N: 146) of the NST tests that were reactive while 28.8% (N: 59) were non-reactive; of these 54 patients underwent PTC: 79.6 (N: 43) were negative, 16.6% (N:9) were positive and 3.8% (N:2) were equivocal. There were three perinatal deaths: two occurred in patients with positive PTC and in the other with negative PTC, more than one week had elapsed between test performance and delivery. A correlation was found between positive PTC and perinatal mortality, lower birth weight, lower Apgar index and possible intrauterine growth retardation in these patients. In conclusion, the prognostic usefulness of antepartum fetal monitoring in high-risk patients was confirmed.

Sagua [6] in their thesis "Antepartum non-reactive fetal status and perinatal outcomes in pregnant women attended by cesarean section at the National Maternal Perinatal Institute, July - October 2016", linked the non-reactive fetal status before delivery and adverse perinatal outcomes, the study was observational retrospective cohort, in a sample of 395 pregnant women of ≥ 34 weeks of pregnancy, who ended in cesarean delivery, a cohort group by 120 pregnant women with non-reactive fetuses; The second group consisted of 275 pregnant women with reactive fetuses, with the following results: non-reactive fetuses 30.4% and reactive 69.6%. There were no significant differences in general and obstetric characteristics. The main reason for cesarean section was utero-placental insufficiency, fetal distress and intrauterine growth restriction (58.3%) (p=0.00) (RR 2.91; 95% CI

2.20-3.86). It was concluded that antepartum non-reactive fetal status is not statistically significantly associated with adverse perinatal outcomes in pregnant women attended.

Afanador [7], in the article "Antepartum fetal monitoring in relation to fetal morbi-mortality in the San José de Bogotá Hospital", the NST tests were correlated according to the interpretation given at the San José Hospital and according to the new interpretation following the parameters of Evertson and Schifrin with the state of the child at birth, assessed according to the Apgar, the presence or not of meconium and the state of the newborn's weight. It was possible to conclude that, following adequate interpretation parameters, the NST test is a very accurate method for assessing perinatal status, since there was a direct correlation of the test, being reactive or non-reactive with the Apgar, with the presence or not of meconium and the state of the child's weight at birth.

IV. THEORETICAL FRAMEWORK

Significant adaptations to high altitudes in the lung level

Pulmonary ventilation maintains in the alveoli an O2 concentration determined by the atmospheric pressure, which decreases at higher altitudes which causes the partial pressure of oxygen at altitude to be reduced, creating a "condition of hypobaric hypoxia, the cause of alveolar hypoxia and hypoxemia in humans who live or ascend to high altitudes". Research done by Peruvians at the level of newborns at high altitudes (4540msnm) compared to sea level has shown that the arterial oxygen saturation (SO2) is 80% and hemoglobin is at 20 g/dL; in addition "quantitative histological studies of the pulmonary arteries showed thickening of the middle layer of smooth muscle cells (SMC) in the distal small arteries" that would be a consequence of the fact that physiological thinning does not occur in post-natal life, as in newborns at sea level; taking into account this condition of adaptation at high altitudes, we want to describe the antepartum monitoring of fetuses at high altitudes [8].

Transport of oxygen from maternal lung to fetus

This mechanism will depend on the contribution of oxygen from the external environment to the lungs, since the greater the O2 gradient between the alveolar air and the blood plasma, the greater the diffusion towards the blood through the well-known alveolar-capillary membrane, for this the lungs must be healthy, moreover, the great affinity of hemoglobin (Hb) for O2 allows it to continuously capture from the plasma until it is saturated, which occurs when it contains 110 times more O2 than that which can be fixed by the plasma or water. The ratio of oxyhemoglobin (hemoglobin saturated with oxygen) to reduced hemoglobin (hemoglobin that is not saturated with oxygen) constitutes the oxygen saturation [9].

The capacity of the blood to transport O2 depends principally on that which circulates bound to Hb; each gram of which is capable of transporting 1.39 % O2 volume, which is equivalent to 20.85 vol % in a healthy adult with 15 g of Hb (15 x 1.39 = 20.85) and in the newborn of 2 to 3 days with approximately 20 g% of Hb, the capacity to transport O2 bound to Hb is 27.8 vol %. However during labor, and contrary to some estimates, it is only 16 g%, similar to that of the healthy adult. In addition, the placenta is the exchange barrier that functions as a fetal lung irrigated by 2 types of blood: maternal blood, which circulates through the intervillous space; and fetal blood, which circulates through the chorionic villi, the syncytiocapillary membrane is 0.002 mm thick. Physiologically, fetal hemoglobin has a higher affinity for O2 than adult hemoglobin, which determines a higher O2 saturation of fetal Hb than maternal Hb. The factors that contribute to fetal Hb having a higher affinity for O2 also help the exchange of carbon dioxide (CO2) from the fetus to the mother, because maternal hemoglobin captures fetal CO2 and releases O2 more easily.

When blood returns from the villi to the fetus, there are several points where it mixes with deoxygenated blood coming from the fetus [9].

Blood oxygen saturation in the umbilical vein reaches 50% and in the umbilical artery 20%.

On the other hand, the classification of O2 deficiency is important, therefore it is shown as follows:

1. Hypoxemic hypoxia: due to inadequate oxygenation of Hb.
2. Anemic hypoxia: due to reduced transport capacity of Hb.
3. Ischemic or circulatory hypoxia: due to circulatory or ischemic alteration of the fetus.
4. Maternal circulatory alterations, which can occur in various situations and might be due to pathological conditions that compromise maternal and circulatory oxygenation.
5. Environment [9].

Placental blood flow increases from 115 ml/min at 20 weeks gestation to 410 ml/min at term, the amount of oxygen transferred from the mother to the fetus depends on maternal blood flow to the placenta, which decreases with uterine contractions [10].

Fetal hypoxia

It is pathological and is caused by a decrease in the concentration of oxygen in the tissues, which was preceded by a hypoxemic condition, a condition that occurs due to insufficient supply of oxygen, metabolites (glucose) from the mother to the fetus and the retention of metabolic catabolites and CO2 by the fetus. Glucose is important for the fetus since it provides the energy necessary for cellular metabolic processes in the presence of oxygen (aerobic glycolysis), the metabolism of glucose is completed until the total utilization of energy and after its conversion into pyruvic acid, by the krebs cycle, it is possible to obtain ATP and its final metabolites that come to make CO2 and O2 at the same time the anaerobic metabolism (without the presence of oxygen), stops at the level of pyruvic acid, which is reduced to lactic acid, leading the fetus to a progressive metabolic acidosis, which if not intervened in time could result with an asphyxia [4].

The mechanisms of adaptation to hypoxia are as follows:

- Increased oxygen affinity to fetal hemoglobin.
- Increased capacity of tissues to extract oxygen.
- Increased tissue resistance to acidosis

When gas exchange is interrupted at the placental level, hypoxemia, metabolic and respiratory acidosis occur, a condition known as perinatal asphyxia.

Fetal Heart Rate

The fetal heart rate appears at the end of the third week of embryonic life with the beating of an incipient heart and can be evidenced through Doppler ultrasound from the 6th to 7th week of pregnancy; they are modulated by the autonomic nervous system. It is a long history how the technology to evaluate was obtained, since it was first perceived by a French doctor Marsac in 1650, who was ridiculed for having told his experience of having heard a "sound" in the abdomen of one of his patients, until Roberto Caldeyro and Hon devised the continuous monitoring of the fetal heart rate. Following the study of these great scientists, the German researchers perfected the equipment and began to commercialize it [2].

Fetal Heart Rate Classification

There are several classifications of fetal heart rate, which have been proposed over time, some of them are shown in Table I:

TABLE I. PARTICIPATING POPULATION

Description	Dr. Calderyro Barcia	Dr. Hon	NICHD 2008
Marked Tachycardia	[180 - + >	[180 - + >	
Moderate Tachycardia	[160 – 180>	[160 – 180>	[160 – +>
Weak Tachycardia	[150 – 160>		
Normal	[120 – 150>	[120 – 140>	[110 – 160>
Weak Bradycardia	[110 – 120>		
Moderate Bradycardia		[100 – 120>	< - - 110>
Marked Bradycardia	< - - 110>	< - - 100>	

Source obtained by [10]

Fetal Heart Rate Elements

The elements of the fetal heart rate (FHR) also called parameters are four and are important because they allow us to make a thorough evaluation of the fetal heartbeat, which ultimately reflects the state of the central nervous system (CNS). The four are: Baseline, variability, acceleration and deceleration:

Baseline

It is the average of the FHR recorded in 10 min at maternal rest, established outside the periodic changes, the average is between 110 - 160 bpm. otherwise, identifiable baseline segments of at least 2 minutes (not necessarily contiguous) in a window of 10 minutes should be sought; if not, it will be declared indeterminate [11]. In the case of being indeterminate, the previous segments can be traced, if they do not exist, the graph will continue to be plotted for a longer period of time until it is determined. To determine the baseline it is important to take into account the considerations given by NICHD which indicates that the mother should be in a period of rest, if the heartbeat is stable it should be in a window of 10 minutes, excluding accelerations and decelerations and periods of marked variability (>25 beats per minute or bpm), also FIGO advises that pre-term fetuses tend to have values at the high end of this range and post-term at the low end. When the baseline is altered there may be Tachycardia, FHR greater than 160 beats for more than 10 minutes and Bradycardia when it is less than 110 beats for more than 10 minutes, or less than 30 beats from baseline [12].

Variability

These are the oscillations that occur in amplitude and frequency, at the baseline heart rate. The variability is quantified visually as the amplitude from peak to background in beats per minute, according to NICHD is classified as shown in Table II [13]:

TABLE II. CLASSIFICATION OF VARIABILITY BY THE INTERNATIONAL FEDERATION OF GYNECOLOGY AND OBSTETRICS (FIGO - 2015)

Clasification	Values
Absent	Frequency < 3 bpm, Amplitude undetectable
Minimum	Amplitude <= 5 bpm
Moderate, Normal	6 < Amplitude < 25 bpm
Marked, Severe or skip pattern	Amplitude > 25 bpm

Skip pattern, also known as excessive, marked and exaggerated variability, manifests in the face of fetal hypoxemia, as a result of excessive vagal activity, it is almost always accompanied by bradycardia and is the result of cephalic compression of the mature, post-term fetus [14].

Variability may be decreased by the following events: congenital cardiac anomalies accompanied by bradycardia, by drugs acting as central nervous system depressants (morphine, diazepam, magnesium sulfate) and parasympatholytic agents (atropine and hydroxyzine) and central adrenergic agents (methyldopa).

It is important to mention the sinusoidal pattern, shown in Figure 1:

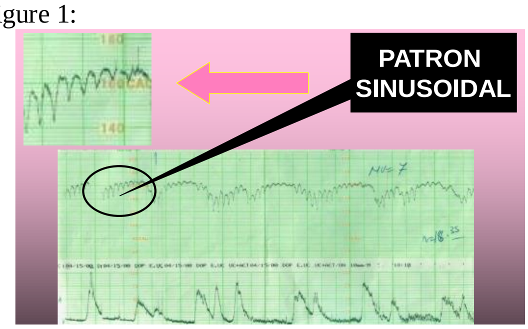


Figure 1: Cardiotocographic tracing with sinusoidal pattern [15]

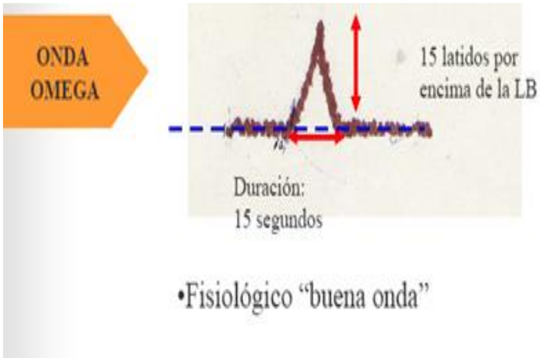
It is defined as an undulating pattern, it is unusual and ominous; it has a strict definition, basal FHR of 120 to 160 beats/min with regular oscillations with 3 to 5 waves per minute and persisting for 20 minutes or more without accelerations.

Accelerations

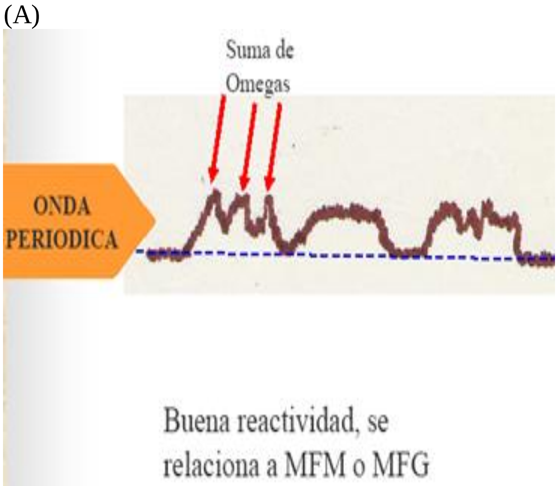
It is the abrupt rise in less than 30 seconds from the onset of acceleration of baseline FHR by 15 beats and with a minimum duration of 15 seconds, in terms (≥32 weeks) it is considered 10 beats per 10 minutes minimum, in both cases it should not exceed 10 minutes [16].

Within this, types are defined by the shape, duration and amplitude of the wave that is graphed and by its relation to uterine movements and contraction.

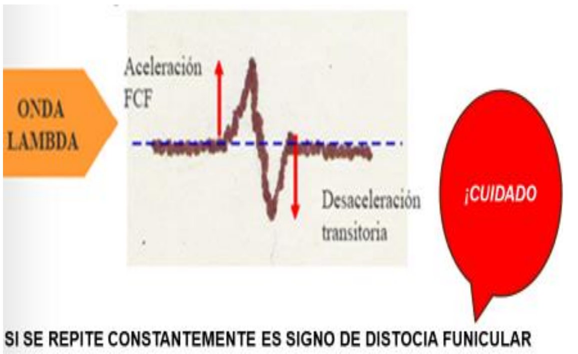
According to the Waveform shown in Figure 2:



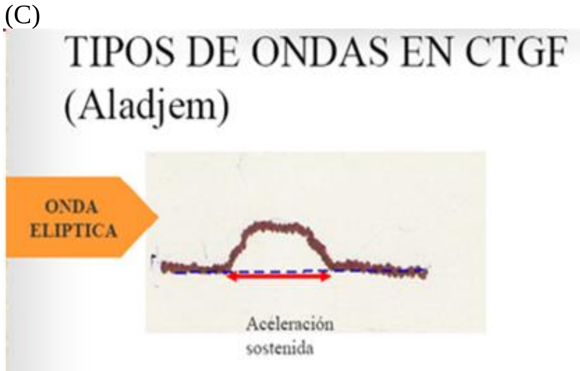
(A)



(B)



(C)



(D)

Figure 2: Acceleration types (A, B, C and D) [17].

Also known as sustained pregnancies that last more than two minutes but less than 10 minutes, they are related to pregnancies of 35 to 36 weeks.

According to its relation to uterine movements and contractions they can be:

- NON-PERIODIC ACCELERATIONS:

These are accelerations that occur in response to fetal movements. They determine fetal reactivity, which is what we look for in the non-stress test (NST).

- PERIODIC ACCELERATIONS:

This term refers to the accelerations that occur simultaneously with uterine contractions, as it can be seen in Figure 3.

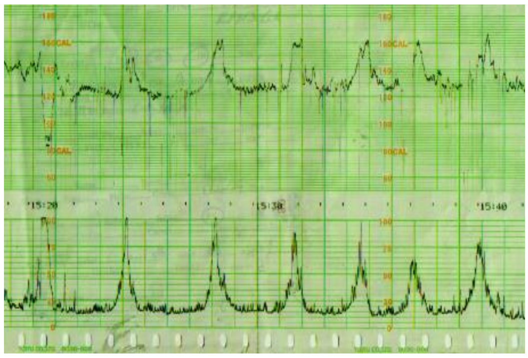


Figure 3: Pure periodic accelerations.

PERIODICAL COMPENSATORY ACCELERATIONS

These are the accelerations that occur before a deceleration, also called "shoulders", illustrated in Figure 4.

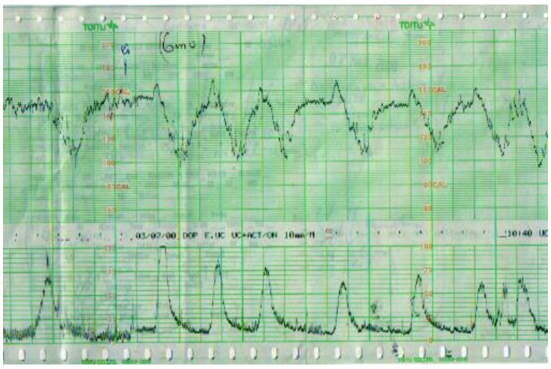


Figure 4: Periodical compensatory accelerations.

Decelerations:

It is the transient decrease in fetal heart rate, which must meet two parameters:

- Lasting more than 15 seconds and less than 10 minutes.
- Having 15 or more beats below baseline.

Deceleration types:

There are four types: early, late, variable and prolonged, as shown in Figure 5, each of which is discussed as follows:

EARLY DECELERATION

They are also known as precocious, type I and formerly called "intrapartum deceleration of type I". It is produced by cephalic compression, which leads to endocranial hypertension, producing a decrease in cerebral blood flow that causes cerebral and vagal center hypoxia, as a result of which the vagal stimulus is generated causing the deceleration to occur with the following characteristics.

They are symmetrical and associated with the contraction, it is a mirror image of the uterine contraction. Its nadir coincides with the acme of the contraction, however generally the nadir does not fall below 100 beats per minute from onset to nadir takes ≥ 30 seconds and its duration is less than 90 seconds. Therefore it is generally associated with a normal baseline and undergoes modification with atropine [12], [17].

LATE DECELERATION

They are also called type II, formerly called as "type II intrapartum decelerations". It is produced when the myometrial vessels are compressed by uterine contraction, generating a reduction of maternal blood flow in the intervillous space, consequently the oxygen pressure at fetal level falls below its critical level (18 mmHg). It is characterized by resembling the precocious in its form, its onset is after the acme of the contraction or with decalage of 15 to 20 seconds post acme, the nadir of deceleration is mostly between 20 to 25 beats per minute below baseline. They are never normal, if they are the result of small contractions it indicates severe placental involvement, they are almost always associated with tachycardia or bradycardia, decreased variability or jumping rhythm salvos. Special care must be given if they occur in each contraction, if they last 90 seconds or more, and if their nadir is below 100 beats per minute as it may injure the midbrain and leave sequelae in the fetus [17] [18].

VARIABLE DECELERATION

It is a steep fall of the FHR, it takes less than 30 seconds from the beginning of the deceleration to the beginning of the nadir of the deceleration, its duration is greater than 15 seconds and less than two minutes, its name is due to the fact that they occur in a varied form in each contraction, there are other characteristics whose clinical significance necessitates further research.

It is the most common pattern in labor, its nadir is below 25 beats of the baseline, it does not last more than 60 seconds and modifies with the change of maternal position as well as with the application of atropine.

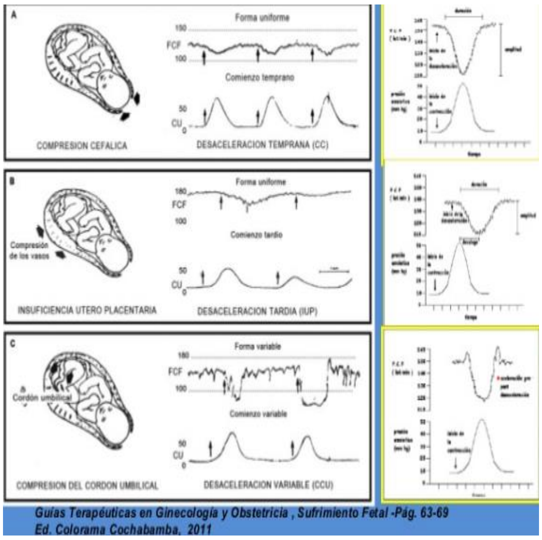


Figure 5: Deceleration types

PROLONGED DECELERATION

It is the decrease of the fetal heart rate, in 15 beats or more, in reference to the baseline with a duration greater than or equal to two minutes and less than 10 minutes.

They are produced by two mechanisms:

a) Due to compression of the vena cava, called vena cava syndrome.

b) By compression of the abdominal aorta, known as the poseiro effect.

INFERIOR VENA CAVA SYNDROME

It is an accident that occurs during pregnancy at the end of the second trimester as a consequence of the pregnant uterus becoming large and heavy enough to compress the inferior vena cava and the abdominal aorta in the supine position, also this compression can be caused by abdominal or pelvic tumors [18]; occurring in 10-15% of pregnant women at term, which manifests itself in about 1 in 10 pregnant women, including: hypotension, tachycardia, diaphoresis, nausea, vomiting, abdominal pain, dyspnea, dizziness and restlessness [19]. It is characterized by lasting the same or more than two minutes and its recovery is slow. Management consists of: change of position to left lateral decubitus, hydration, oxygen therapy, while search for cause and correct it.

POSEIRO EFFECT

It is a regional hypotension suffered by the mother only in the abdominal and lower part, which produces alterations in the fetal heart rate, mainly occurring in the third trimester of pregnancy and during labor. It is triggered by compression of the abdominal aorta and primitive iliac arteries in more than 50% of its caliber, producing decreased maternal blood flow to the intervillous spaces of the placenta, and hypotension of the lower limbs, is asymptomatic, so it is considered more dangerous, as it can go unnoticed. Fetal movements: Fetal movements begin to be perceived by the mother between the 15th and 20th week of gestation, however this depends on obesity, personality, maternal occupation, intensity of fetal movement, etc. Fetal movements are among the earliest variables to appear in the development of the CNS of the fetus. The nervous centers that regulate it, located in the cerebral cortex and nuclei, are late depressed in the face of hypoxia. As gestational age advances, fetal motor activity intensifies, reaching its maximum between 28 and 32 weeks. Subsequently, a gradual decrease occurs as gestation progresses due to an increase in fetal sleep periods associated with maturity of the central nervous system.

Respiratory muscles develop early in pregnancy. From the fourth month of gestation, the fetal respiratory movement has an intensity that can move amniotic fluid both in and out of the respiratory tract. In the fetus there is a paradoxical thoracic movement on inspiration: there is depression of the chest wall and expansion of the abdominal wall. The frequency of this movement increases from the 24th week of gestation onwards. They appear intermittently in a spontaneous manner and are present in 14% of the observation time between the 24th-28th weeks; in 32% at the 35th week, being associated with cycles of 40-80 minutes of fetal activity and alertness. Breathing rate becomes slower and more regular as pregnancy progresses. Respiratory movements are present approximately 30% of the time during fetal activity periods and 14% of the time during fetal rest periods. The fetal heartbeat is first observed by transvaginal ultrasound at 4.5 to 5 weeks of gestation (2.5 to 3 weeks after fertilization) at a rate of 100 beats/minute. It increases rapidly to 150 beats/minute between the 5th and 8th week, rising to 170 beats/minute between the 8th and 10th week. It then falls to 150 beats/minute at the 15th week. Each fetus then tends to maintain a constant heart rate within a range of +/- 5 to 10 beats/min, with variation between successive R-R intervals determining the characteristic variability of the recording.

Fetal Movements

It is one of the cheapest and most homemade indicators that gives us information about the fetus, perceived by the mother, today we can evaluate in various ultrasound forms, in the monitoring, an important indicator in the NST, as it is related to the accelerations. At the 7th week of pregnancy slight movements of the neck can be noticed; by the 8th week general movements can be noticed and hiccups can be perceived by the mother from 16 weeks onwards. Cardiotocographic evaluation is classified into single movements and multiple movements. Individual fetal movements are movements of short duration (less than 5 sec.) easily detectable by the mother and by the tester; a single, well-defined net wave is seen in the recording, but may be associated with other movements and shown repetitively. They are subdivided into:

Isolated movement that by ultrasound corresponds to the movement of a generally lower extremity. These are known as "simple movements".

Repetitive movements, which by ultrasound is related to sudden movements of the thorax (e.g. fetal hypo).

Multiple fetal movements are two or more waves that appear as a mountain range composed of several ridges of varying amplitude and duration. These movements are also referred to as rolling movements [20].

Antepartum fetal monitoring

Antepartum electronic fetal monitoring consists of the evaluation of the fetal heartbeat through a continuous recording of the fetal heartbeat, by means of a monitor, which is responsible for charting the fetal heart rate for a period of no less than 20 minutes, in which all the characteristics are recorded. This allows us to quantify the elements of the fetal heart rate, which upon interpretation will give us the appropriate diagnosis [5]. This test is based on the evaluation of the nervous system, if it is in good condition it will react with transient accelerations in response to fetal movements, the study has a specificity of 90% in normal pregnant women and in pregnant women with pathology it reaches 99%, the problem of the test is its low sensitivity 45 to 50%, therefore it is necessary to perform another test when it is not reactive. However, in clinical practice it is not clear which of the interpretation tables should be used for evaluation since in Peru there are two currents, some using the FISHER table, headed by the Lima Maternity Hospital, while other hospitals, such as the San Bartolomé de Lima, use the NICHD test for interpretation. In my training as a specialist, teacher Cárdenas (16), proposes the FISHER test for the TNS, since it gives great importance to the accelerations produced while NICHD does not take into account the reactivity as an indicative to classify as a normal pattern, these parameters respond well in intrapartum monitoring, since the intrauterine child who is in a process of expulsion and trapped by the contractile force of the uterus cannot move as outside labor, therefore the absence of accelerations is not an indicative to intervene.

Little literature has been found on the parameters proposed by FISHER, however, in a systematic review conducted, we found as described in Table III:

TABLE III. MODIFIED FISHER TEST

Clasification	0	1	2
Baseline	< 100 /> 180	100 – 119 161 - 180	120 - 160
Variability	< 5	5 -9 o ≥25	10 - 25
Accelerations in 20 min of recording	0		2 or more ≥5 within 30 minutes
Decelerations	DIPII ≥ 50% DIPIII ≥ 60%		
Fetal movements within 20 min	0	1 - 4	≥5

Interpretation according to FISHER test:
Physiological: 8 to 10 points.
Doubtful: 5 to 7 points.
Pathological: ≤ 4 points.

The interpretation varies according to the test used to evaluate the cardiotocographic tracing and each hospital preferences to use an adapted instrument. In this case, the Daniel Alcides Carrion Hospital uses the same instrument as the Lima Maternity Hospital, whose interpretation of the test is as described in Table IV:

TABLE IV. FISHER SCORE INTERPRETATION

Score	Fetal Status	Prognostic	Clinical Approach
8 a 10	Physiological	Favorable	None
5 a 7	Doubtful	Professional Criteria	Coad. CST or other test might be recommended
≤ 4	Severe	Unfavorable	Removal if necessary

Source: Cardiotocographic report, fetal medicine unit. I.N.M.P[21]

The result of a non-stressful test can be:

Reactive (normal): When the heart rate increases 15 beats from baseline and this elevation lasts more than 15 seconds on two or more occasions during the examination in 20 minutes and 5 in 30 minutes, which, taking into account Table 3, would correspond to the physiological fetal state with a favorable prognosis.

Non-reactive: Less than 2 FHR accelerations in a period of 40 minutes of observation and after application of vibroacoustic stimulus there is no change in heart rate; in these cases it will depend on the clinical criteria of the treating professional; therefore, another test must be performed.

Indications of the non-stress test:

- Pregnancy-induced or chronic hypertension.
- Gestational or insulin-dependent diabetes.
- Severe anemia or other hematologic diseases
- Heart diseases
- Collagen diseases
- Renal diseases
- Thyroid diseases
- Maternal anxiety
- Poor obstetrical history
- At 28 weeks of pregnancy, poor obstetrical history, fetal death
- Before 28 weeks of pregnancy in Rh isoimmunization
- Suspected funicular dystocia
- Alteration of the amniotic fluid
- Decrease in fetal movements
- Suspected Intrauterine Growth Restriction
- Abnormal FHR x auscultation
- Multiple Pregnancy
- Threat of preterm labor
- Preterm RPM

Antepartum Fetal Monitoring. - Continuous recording of the fetal heart rate, with the help of an electronic monitor in an external way through the abdomen of the pregnant women, which allows us to evaluate the fetal well-being through the evaluation of the elements of the fetal heart rate. A complete description of the operation of the electronic fetal monitoring performed is shown in Table V:

TABLE V. OPERATIONALIZATION OF ANTEPARTUM ELECTRONIC FETAL MONITORING

PREGNANT HEMODYNAMICS					
CONCEPTUAL DEFINITION	*OPERATIONAL DEFINITION*	*INDICATORS*	*ITEMS*	*VALUE*	*Variable type*
Continuous external recording of fetal heart rate, which allows us to assess fetal well-being by looking for transient accelerations in response to fetal movements which indicates CNS integrity (20)	Continuous fetal heart rate recording for 30 minutes, between 37 to 40 weeks in which the elements of fetal heart rate and fetal movements are evaluated with the FISHER test	Residence of the pregnant woman	Altitude of residence	Numeric	Discreet
		Assessment of fetal heart rate	Baseline	Numeric	Discreet
			Variability	Numeric	Discreet
			Accelerations	Numeric	Discreet
			Decelerations	Numeric	Discreet
		Fetal movements	Fetal movements number	Numeric	Discreet

V. METHODOLOGY AND RESULTS

TEMPORAL AND SPATIAL SCOPE: Daniel Alcides Carrion Regional Hospital, whose origin dates back to October 12, 1979, is a hospital located at 4380 m.a.s.l., in the province of Cerro de Pasco, capital of the department of Pasco; named in honor of the martyr of Peruvian medicine born in the locality of Cerro de Pasco. The new infrastructure was recently inaugurated, with state-of-the-art equipment that allows it to serve more than 300,000 inhabitants. It is category II-2.

The hospital has a built-up area of 23,000 m2, five floors, and 18 observation beds, 4 operating rooms, 39 consulting rooms for different specialties, a delivery room, 120 hospital beds, 12 ICU beds, 19 cribs, a CT scanner, a mammograph and four laboratories.

TYPE OF RESEARCH: The type of research corresponds to observational, descriptive, prospective, cross-sectional, the required data were collected as presented in the environmental context [22].

LEVEL OF RESEARCH: It is descriptive, we aimed to find out how the elements of fetal heart rate behave through antepartum electronic fetal monitoring. No intervention was done in the research [22].

POPULATION, SAMPLE AND SAMPLING: Population: 155 pregnant women who underwent an electronic antepartum monitoring test, only non-stress tests (NST), registered during the month of January and February 2020. Sample: we worked with the entire population within the study period.

INSTRUMENT AND TECHNIQUE FOR DATA COLLECTION: The input to collect the antepartum electronic fetal monitoring data was the cardiotocographic tracings of the pregnant women who participated, which was analyzed by the researcher, using a Data Collection Record based on

the FISHER test, currently used by most hospitals in Peru, such as the Instituto Materno Perinatal de Lima and the one presented in the case study.

Fetal monitoring is performed and interpreted by the obstetrician and verified by a specialist in gynecology and obstetrics, we could consider this process as a quality control of test.

Moreover, each file has passed through a quality control before being entered into the database.

DATA ANALYSIS TECHNIQUES AND PROCESSING: A Microsoft Excel 2010 spreadsheet was used for data analysis, while for processing, descriptive statistics, tables of measures of central tendency and proportions were used, presented in one- and two-entry tables and line graphs.

RESULTS: The study took place in 155 pregnant women who underwent a non-stress test (NST) at the electronic fetal monitoring service of the Daniel Alcides Carrion Hospital in Cerro de Pasco, a facility that attends patients from 2008 m.a.s.l. to 4350 m.a.s.l., which is why the procedure took into account the variable of altitude.

TABLE VI. BEHAVIOR OF ANTEPARTUM FETAL MONITORING - NST AT THE DANIEL ALCIDES CARRION HOSPITAL, CERRO DE PASCO, JANUARY AND FEBRUARY 2020

	Baseline	Variability	Acceleration within 30 minutes	Fetal mov.
Average	134	10	6	8
Maximum	160	20	10	16
Minimum	100	4	0	0

Table VI shows that the average baseline was 134 fetal heartbeats with the maximum of 160 and the minimum of 100; there was an average variability of 10 heartbeats with a maximum of 20 and a minimum of 4; likewise the average acceleration was 6 times in 30 minutes with the maximum acceleration being 10 and the minimum 0; and finally for fetal movements the average was 8 while the maximum was16 and the minimum 0.

TABLE VII.
EHAVIOR OF ANTEPARTUM FETAL MONITORING - NST AT THE DANIEL ALCIDES CARRION HOSPITAL, CERRO DE PASCO, JANUARY AND FEBRUARY 2020 BY ALTITUDE

FISHER TEST	Altitude 2008 – 2999 m.a.s.l		Altitude 3000 – 3999 m.a.s.l		Altitude 4000 – 4350 m.a.s.l.	
	n=25	%	n=25	%	N=105	%
Baseline						
< 0- 100> 180	0.0	0.0	0.0	0.0	0.0	0.0
<100 – 119> <161 – 180>	1.0	4.0	2.0	8.0	7.0	6.7
<120 – 160 >	24.0	96.0	23.0	92.0	98.0	93.3
Variability						
< 5	0	0	1	4	0	0.0
<5 – 9> o > 25	7	28	3	12	29	27.6
< 10 - 25>	18	72	21	84	76	72.4
Acceleration						
0	0	0	0	0	1	1.0
< 1 - 4 >	2	8	4	16	10	9.5
≥ 5	23	92	21	84	84	80.0
Fetal movements						
0	0	0	0	0	1	1.0
< 1 - 4>	1	4	3	12	13	12.4
≥ 5	24	96	22	88	91	86.7

In general terms, the FISHER test elements of the antepartum monitoring NST behave similarly in relation to altitude and most of them are in normal conditions, although a small proportion is outside the normal range.

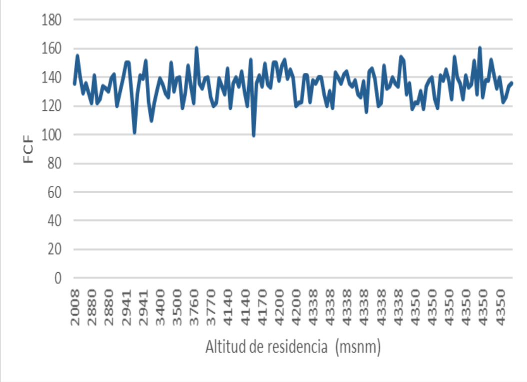


Figure 6: Behavior of the baseline in relation to the altitude at which the pregnant woman resides, Hospital Daniel Alcides Carrion de Cerro de Pasco, 2020

Figure 6 illustrates that the baseline has an optimal behavior up to 2941 m.a.s.l., from there it descends in some women living between 2941 and 4170 up to 100 beats.

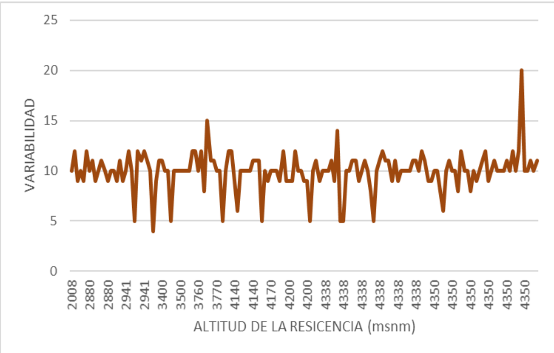


Figure 7: Behavior of the variability in relation to the altitude at which the pregnant woman resides, Hospital Daniel Alcides Carrion de Cerro de Pasco, 2020

Figure 7 illustrates that it is up to 2941 m.a.s.l that the variability is around 10 beats, from there a fluctuation of 4 to 15 beats is seen up to 4350.

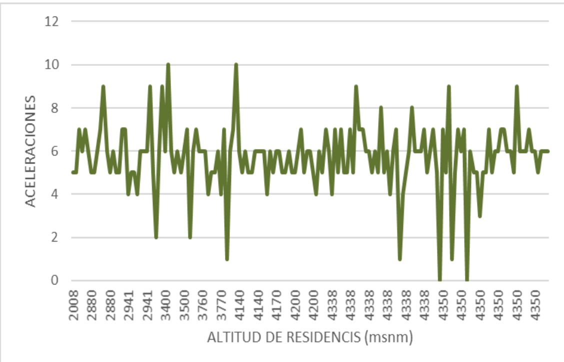


Figure 8: Behavior of the acceleration in relation to the altitude at which the pregnant woman resides, Hospital Daniel Alcides Carrion de Cerro de Pasco, 2020

Figure 8 illustrates that acceleration is around 6, with a slight tendency to decrease at higher altitudes down to zero in a sporadically manner.

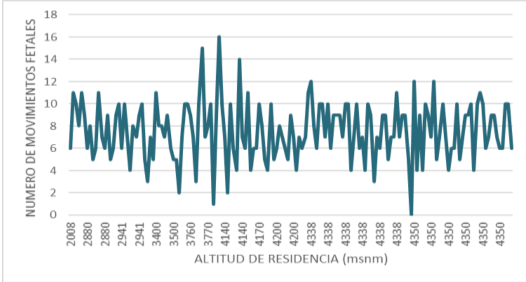


Figure 9: Behavior of the fetal movements in relation to the altitude at which the pregnant woman resides, Hospital Daniel Alcides Carrion de Cerro de Pasco, 2020

Figure 9 illustrates that fetal movements remained between 3 to 11 movements up to 2941, extending the range from 1 to 16 (maximum reached) from 2941 to 4140, from this altitude to 4350 m.a.s.l. a peak of descent to 0 and a maximum of 12 movements.

VI. DISCUSSION

Electronic fetal monitoring before delivery is among the few procedures that provides us with data on fetal well-being at a lower cost and is accessible in Peru; all second level facilities have an electronic fetal monitor and most of the facilities with basic obstetric and neonatal functions at the first level. Despite the controversies in its use due to its low specificity, if properly interpreted and, considering maternal clinical and environmental factors, it helps us to prevent perinatal asphyxia (6) (7).

Nevertheless, it is known that the fetal adaptation to be able to capture the greatest amount of oxygen guarantees its oxygenation; however, when the maternal contribution is not adequate at the level of the placental intervillous spaces, the physiological process of exchange could be compromised. It is understood that the higher the altitude, the lower the barometric pressure, the lower the availability of oxygen in the environment to be captured, producing symptoms called altitude sickness for visitors, and in any case, in the face of this environmental hypoxia, even the natives of high altitudes generate an adaptation process (placenta of greater extension and weight), even so, the injury of altitude hypoxia is denoted, generating as a consequence intrauterine growth retardation (IUGR) and low birth weight (8) (9).

The aforementioned is to explain the reason why we evaluated each element of the fetal heart rate of the NST, developed at the Daniel Alcides Carrion Hospital in Cerro de Pasco. On average, the baseline was 134 beats, registering 160 beats as maximum and 100 as maximum, only slight bradycardia was found; the average variability was 10 beats, there was a minimum variability of four beats, up to 16 movements were found in 30 minutes, comparing with the FISHER test, in general terms, the behavior of the elements has been within normal parameters only finding slight bradycardia in particular cases (10).

When analyzing with the FISHER test regarding the altitude, most of the analysis remained within normality and slight variation was observed, within the baseline there was slight bradycardia in pregnant women living at 2941 to

4170, there was also a decrease in the other elements at this altitude (variability, acceleration, movements); the acceleration suffered a slight decrease due to the altitude of residence of the pregnant woman, which could be due to the fact that in any case, despite being at different altitudes, the patients attended suffer a slight decrease that may homogenize their physiology. In future research it would be interesting to compare with pregnant women from the coast; on the other hand, the tendency for the fetal heart rate elements to behave in a similar way would be due to maternal and fetal adaptation to face hypoxia at higher altitudes (8).

VII. CONCLUSIONS

Prenatal care was affected by the pandemic and showed lower rates than in the non-pandemic period, but left the following conclusions.

1. The behavior of antepartum fetal monitoring - NST has been within normal values according to the FISHER test, finding the average baseline at 134 beats, variability 10 beats, accelerations 6 in 30 minutes and fetal movements 8 in 30 minutes.
2. Baseline remained between 100 to 160 beats, with little variation observed.
3. Variability remained between 4 to 15 beats with a slight decrease at the highest altitudes.
4. Acceleration tends to decrease slightly at higher altitudes.
5. Fetal movements behave similarly in relation to the altitude.

VIII. RECOMENDATIONS

To the case study hospital: To generate its maternal and neonatal care guidelines incorporating the strategies generated aligned to the national guidelines, which is suggested because, being a provincial hospital and having an assigned population has its own particularities in maternal care that is giving results. Likewise, it is suggested to continue with research in the line of perinatal health, due to the adjustments that must be made as it is located in the highest place in the world and there are several opportunities for research.

Finally, further research is recommended in the area of perinatal health, where there are some gaps to be investigated. Being in the highest place in the world, there are several research opportunities that would be interesting to compare with study populations of coastal altitudes, for example.

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