

# Comparison between Doppler and Non-Stress Test in Pregnant Women with Oligohydramnios for Assessment of Perinatal Outcome at Post Date Pregnancy

**Dhuha Nadhim Ahmed**

M.B.Ch.B

**Dr. Suha Abdul Jaleel Wadi**

M.B.Ch.B, D.G.O., C.A.B.O.G, Consultant in Obstetrics  
and Gynecology, Al-Elwiya Maternity Teaching Hospital

**Abstract: Background:** High-risk pregnancies, especially with oligohydramnios, significantly increase infant mortality and morbidity. Obstetrics focuses on preventing complications, with Doppler and NST being key in assessing fetal health. Oligohydramnios, varying in incidence and severity, can lead to diverse perinatal outcomes, including increased cesarean sections rate and fetal pulmonary complications.

**Aim of the study:** To compare the value of fetal doppler ultrasound and fetal non-stress test in prediction of perinatal outcome in oligohydramnios at postdate pregnancy.

**Patients and methods:** This cohort study was conducted at Al-Elwiya Maternity Teaching Hospital from 1st January to 1st December 2023, including 100 post-date pregnant women with oligohydramnios. Exclusions includes active labor, contraindications to vaginal delivery, and refusal to participate. Data collection covered demographics, medical history, surgical history, physical exams, Doppler ultrasound findings, and non-stress tests. Outcomes for both mother and neonate, including delivery type, complications, and neonatal health, were recorded, ensuring ethical considerations and confidentiality.

**Results:** This study classified post-date pregnant women with oligohydramnios into four groups based on NST and Doppler results. Group 1 (reactive NST, normal Doppler) comprised 32%, Group 2 (normal NST, abnormal Doppler) 26%, Group 3 (abnormal NST, normal Doppler) 30%, and Group 4 (both abnormal) 12%. It found significant differences in delivery modes, with more cesarean sections in Groups 2 and 4. NICU admissions and IUGR incidence varied notably across groups, highlighting the importance of these tests in predicting adverse perinatal outcomes.

**Conclusion:** NST and Doppler effectively assess perinatal outcomes in oligohydramnios, guiding delivery methods and NICU admissions, and highlighting variable risks.

## *Chapter one*

### *Introduction*

#### 1. INTRODUCTION

##### 1.1. Background and epidemiology

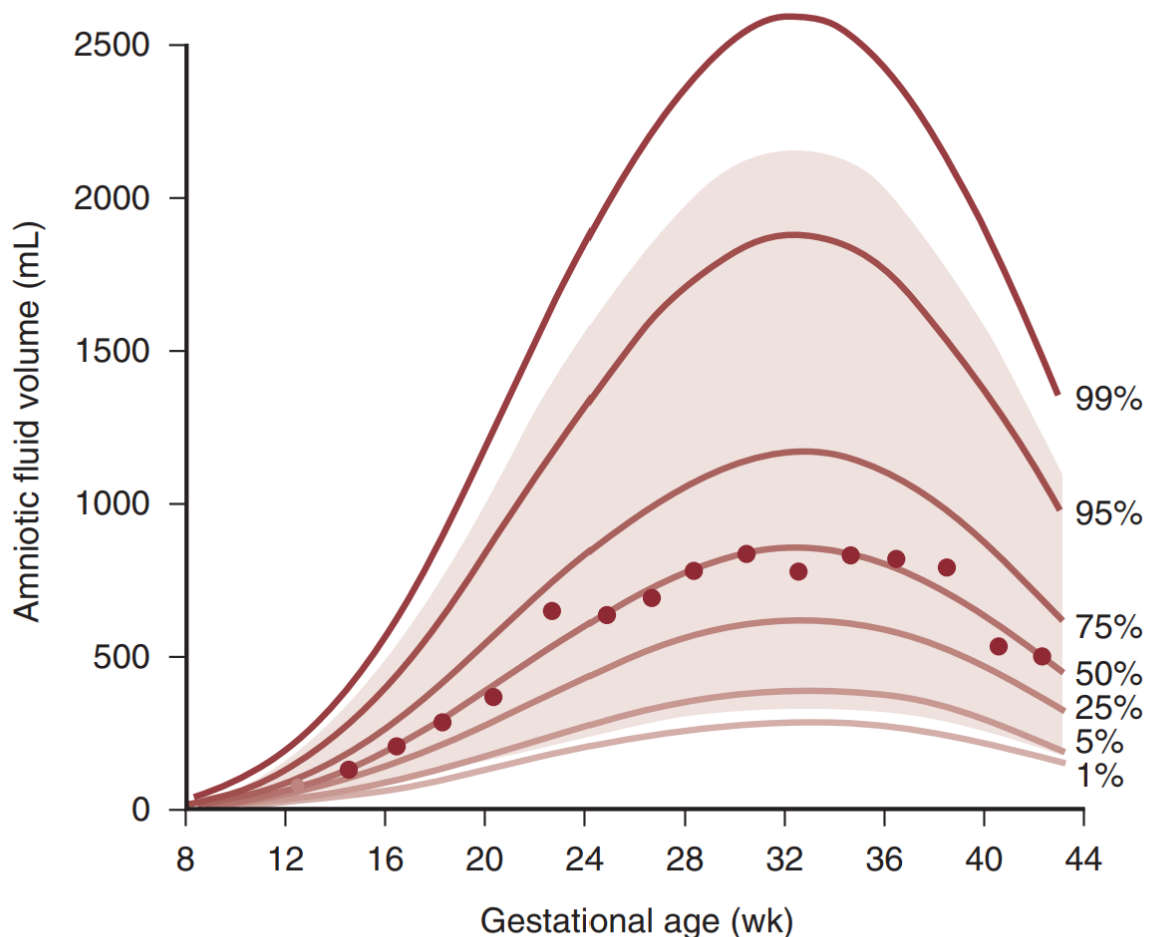
While it is every woman's desire to give birth to a healthy child, complications might arise during pregnancy if either the mother or the fetus is ill. Possible increases in mother and infant mortality and morbidity associated with a high-risk pregnancy. Seventy-five percent of perinatal deaths and eighty percent of maternal deaths occur in the 20-30% of pregnant women who match high-risk

criteria.<sup>(1)</sup> In high-risk pregnancies, placental insufficiency can cause fetal impairment in the antepartum or intra partum period<sup>(2)</sup>. The amniotic fluid provides the embryo with a cushioned, temperature-controlled, and injury-proof environment in which to grow and develop. It acts as a key source of nutrition for the developing fetus and possesses bacteriostatic characteristics to stave against infection. At full term, the amniotic fluid volume is around 1000 ml, and it gradually drops for the remainder of the pregnancy<sup>(3)</sup>.

The incidence of oligohydramnios varies widely, from approximately 0.5% to 5%

## 1.2. Definition

Oligohydramnios can be defined as amniotic fluid volume < 5% for gestational age, AFI < 5 cm or maximal deepest pocket < 2 cm. Single deepest pocket (SDP) is the best method for diagnosing oligohydramnios however, most studies evaluating adverse outcomes utilize AFI<sup>(4)</sup>. At 10 weeks of pregnancy, the average AF volume is 20 mL, at 22 weeks it's 630 mL, and at 28 weeks it's 770 mL. There is not much of an increase or decrease in volume between weeks 29 and 37 of pregnancy. The average volume of AF drops precipitously after 39 weeks, to just 515 mL at 41 weeks. Consistent with the higher prevalence of oligohydramnios in post-date pregnancies, AF volume decreases by 33% per week as the pregnancy progresses past its due date<sup>(5)</sup> as in figure(1-1). oligohydrominias are more common in the last trimester<sup>(6)</sup>.



**Figure 0-1: Normal range of amniotic fluid volume in relation to gestational age<sup>(5)</sup>.**

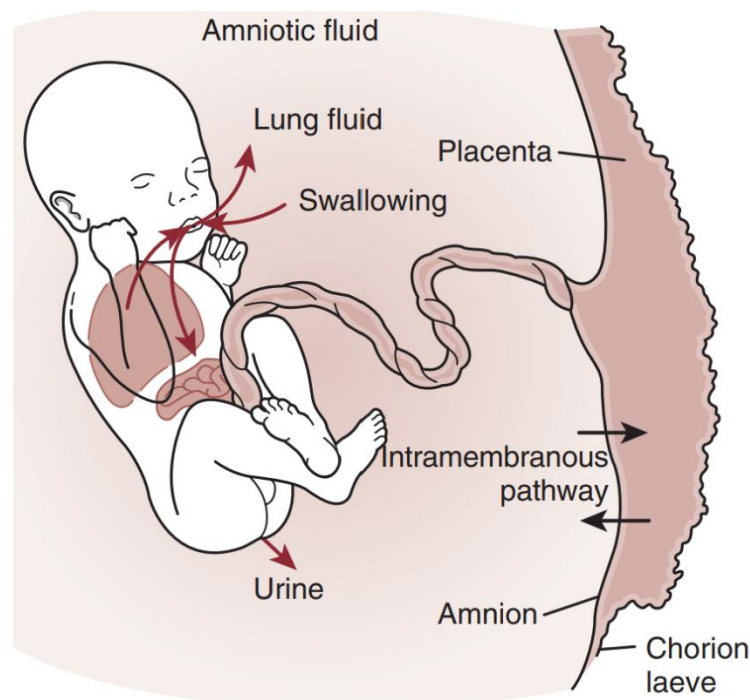
### 1.3. Amniotic fluid dynamics

Amniotic fluid is produced and removed as a result of numerous processes. Amniotic fluid is thought to be produced as a result of fetal urine, which at term is estimated to be between 600 and 1200 mL/day and occurs after the keratinization of the fetal skin at roughly 22 to 23 weeks' gestation<sup>(7)</sup>. Other contributions consist of:

- 1- Tracheal secretions between 60 and 100 mL/kg/day of fetal weight during the last few weeks of pregnancy.
- 2- The intramembranous pathway, which involves the exchange of amniotic fluid and fetal blood to supply the umbilical cord, placental surface, and skin at almost 400 mL/day at term.
- 3- The trans membranous pathway, which involves a direct exchange of amniotic fluid and material blood inside the uterus across the fetal membranes<sup>(5)</sup>.

The evacuation of amniotic fluid by the fetus during pregnancy is accounted for via swallowing, which is estimated to remove between 200 and 1500 mL each day. Additionally, the fetal lung secretes sizeable volumes of fluid throughout the second part of pregnancy, adding to the volume of amniotic fluid<sup>(8)</sup> as in Figure 0-2.

1000 mL of fluid enters and exits the amniotic compartment every day during the late stages of pregnancy, when the amniotic fluid volume ranges from 700 to 800 mL on average. According to more recent data (obtained using the dye dilution technique), amniotic fluid volume is dependent on gestational age, maintained within a fixed range, appears highly regulated, and peaks between 36 and 38 weeks' gestation. Thereafter, it declines or, in accordance with more recent data, becomes maximal near term<sup>(9)</sup>. It is yet unknown what causes the relative decrease in amniotic fluid volume toward term and in straight forward post date pregnancies. The idea that the fetal membranes are essential for maintaining amniotic fluid volume and composition is supported by both experimental and clinical investigations. The idea that the fetus could contribute to the start of spontaneous uterine contractions (and eventual labor) by lowering amniotic fluid content at advanced gestational ages seems appealing. The enhanced uterine contractility associated with spontaneous or induced membrane rupture or amniocentesis far from or at term would be similar to the suggested mechanism<sup>(10)</sup>.



**Figure 0-2: Water circulation between the fetus and amniotic fluid.**

Fetal swallowing and intramembranous flow are the main methods of absorption, while the main sources of AF water are fetal urine and lung fluid.<sup>(5)</sup>

### Factors affecting amniotic fluid

Maternal hydration state appears to have a major impact on amniotic fluid content, as shown by Goodlin et al<sup>(11)</sup>. Ultrasound confirmed an increase in amniotic fluid content when substantial intravenous maternal hydration was administered to a critically dehydrated patient with oligohydramnios, as described by Sherer et al in 1990<sup>(12)</sup>. Numerous later prospective studies supported this finding, showing that both oral and intravenous hydration of the mother resulted in statistically significant increases in the amniotic fluid index (AFI). In a prospective research, Flack et al<sup>(13)</sup>. found that women with third-trimester oligohydramnios (AFI 5 cm) benefited more than those with normal amniotic fluid volume from short-term maternal oral hydration. Acute maternal hydration (2 L per 2 hours) using intravenous isotonic or hypotonic fluid or oral water was investigated for its influence on the AFI in individuals with AFI values of 5 cm at more than 35 weeks' gestation by Doi et al<sup>(14)</sup>. Oral or intravenous hydration may correct uncomplicated oligohydramnios, as shown by Chandra et al<sup>(15)</sup>, showing that neither intake route appears to be preferable<sup>(16)</sup>.

#### 1.4. Etiology and pathophysiology of oligohydramnios

It is without amniotic fluid that the embryonic respiratory, digestive, urinary, and musculoskeletal systems could not form normally. Transudation between placental and fetal skin surfaces is the primary source of amniotic fluid in the early fetal period. Fetal urine is the primary source of the fluid after keratinization of the skin (about 22–23 weeks of gestation), with minor contributions from the fluids of the mouth, nose, trachea, and lungs. Fetal swallowing is the primary mechanism for fluid elimination<sup>(8)</sup>. Oligohydramnios can be caused by decreased fetal urine excretion due to decreased production or genitourinary blockage. Fetal growth restriction, twin-twin transfusion syndrome, and maternal medication consumption are all potential pre-renal causes (including the tocolytic indomethacin and other nonsteroidal anti-inflammatories)<sup>(17)</sup> as in table 1-1.

**Table 0-1: Causes of oligohydramnios<sup>(17)</sup>.**

TABLE 120.1 CONDITIONS ASSOCIATED WITH OLIGOHYDRAMNIOS
<b>MATERNAL</b> Uteroplacental insufficiency Hypertension Preeclampsia Diabetes Medications Angiotensin-converting enzyme inhibitors Nonsteroidal antiinflammatory drugs Cocaine abuse
<b>FETAL</b> Premature rupture of membranes Fetal growth restriction Postterm pregnancy Congenital anomalies Fetal renal defects Bilateral renal agenesis Infantile polycystic kidney disease Multicystic dysplastic kidney disease Fetal postrenal defects Posterior urethral valves Urethral atresia Urethral stenosis Megacystitis microcolon syndrome Ureterocele Chromosomal abnormalities Fetal demise
<b>PLACENTAL</b> Twin transfusion syndrome Placental abruption

## 1.5. Post-maturity syndrome

### 1.5.1. Definition

Post-Date or post-mature pregnancy is a condition where a pregnancy extends beyond the usual 40 weeks or 280 days from the last menstrual period. It is typically defined as a pregnancy that extending past the estimated delivery date(EDD) which is also known as due date(at 40weeks gestation). Understanding the various aspects of post-date pregnancy is crucial for managing the potential risks and complications associated with this condition<sup>(18)</sup>.

### 1.5.2. Incidence

The incidence of post-date pregnancies varies but is generally estimated to be around 3-12% of all pregnancies. This wide range is due to differences in population studies, definitions of post-date pregnancy, and obstetric practices<sup>(18)</sup>.

### 1.5.3. Causes of Post-date Pregnancy

Several factors can contribute to a pregnancy becoming post-date, including:

- ✓ Wrong date
- ✓ First Pregnancy: Primi parity is associated with a higher likelihood of post-date delivery.
- ✓ Previous Post-date Pregnancy: History of post-date pregnancy increases the risk in subsequent pregnancies.
- ✓ Male Fetus: Pregnancies with male fetuses are more likely to go post-date.
- ✓ Genetic Factors: Family history of post-date pregnancies suggests a genetic predisposition<sup>(19)</sup>.

### 1.5.4. Pathogenesis

The pathogenesis of post-date pregnancy is not clearly understood. Despite improved understanding of parturition in recent years, we still lack clarity about the exact mechanisms which initiate labour and allow its progression. To have a better understanding of the pathogenesis of post-date pregnancy it is essential to shed some lights on the pathophysiology of parturition and try to understand why these mechanisms fail to be triggered in post-date pregnancies or conversely are triggered earlier in preterm labor. It seems logical that a common ground or a link does exist between these three conditions. The mechanisms of parturition include interactions between hormonal, mechanical and inflammatory processes, in which placenta, mother and fetus each play a vital role<sup>(20)</sup>.

Placental production of the peptide corticotrophin releasing hormone (CRH) has been related to the length of gestation<sup>(21)</sup>.

CRH can directly stimulate fetal adrenal production of Dehydroepiandrosterone (DHEA), the precursor for placental oestriol synthesis. Maternal plasma CRH concentrations correlate with oestriol concentrations. Concurrently the rise in maternal plasma progesterone concentrations that occurs across gestation slows at the end of pregnancy or even falls. This may be due to CRH inhibition of placental progesterone synthesis<sup>(22)</sup>.

### 1.5.5. Clinical Features of post mature infant

The post mature infant presents a unique appearance such as shown in Figure 0-3. Features include wrinkled, patchy, peeling skin; a long, thin body suggesting wasting; and advanced maturity in that the infant is open-eyed, unusually alert, and appears old and worried. Skin wrinkling can be particularly prominent on the palms and soles. The nails are typically long. Most post mature infants are not technically growth restricted because their birth weight seldom falls below the 10th percentile for gestational age. On the other hand, severe growth restriction—which logically must have preceded completion of 42 weeks—may be present<sup>(23)</sup>.



**Figure 0-3: Post-maturity syndrome<sup>(23)</sup>.**

#### 1.5.6. Diagnosis

The diagnosis of a post-date pregnancy primarily relies on accurate dating, which includes:

- Last Menstrual Period (LMP): The date of the last menstrual period provides an initial estimate, assuming a regular menstrual cycle.
- Ultrasound: Early ultrasound (first trimester) is more accurate for dating a pregnancy and can help predict the due date more reliably<sup>(24)</sup>.

#### 1.5.7. Causes of Oligohydramnios in Post-date Pregnancies

1. Placental Aging: As a pregnancy progresses beyond the term, the placenta, which supplies oxygen and nutrients to the fetus, may start to function less efficiently. This aging process can lead to a decrease in fetal urine production, which is a major component of amniotic fluid, thereby reducing the overall fluid volume<sup>(25)</sup>.

2. Fetal Factors: The fetus plays a key role in maintaining amniotic fluid volume, primarily through the production of urine. In post-date pregnancies, if the fetus experiences any compromise in its well-being (such as hypoxia or nutrient deficiencies due to placental insufficiency), it may reduce urine output, leading to oligohydramnios<sup>(25)</sup>.

3. Ruptured Membranes: A prolonged pregnancy increases the risk of the membranes rupturing prematurely. Even small, undetected leaks in the amniotic sac can lead to a gradual decrease in amniotic fluid levels. These leaks can be challenging to diagnose and may not always present with the dramatic "water breaking" scenario<sup>(26)</sup>.

4. Maternal Factors: Conditions within the mother that affect placental blood flow and function can also lead to oligohydramnios. For example, maternal dehydration, can affect the placenta's ability to sustain normal amniotic fluid levels<sup>(26)</sup>.

5. Medications: Certain medications taken during pregnancy, particularly those that affect fluid and electrolyte balance or blood flow to the placenta (like some antihypertensive drugs), can contribute to oligohydramnios<sup>(25)</sup>.

6. Idiopathic Causes: In some cases, the specific cause of oligohydramnios in a post-date pregnancy may not be identifiable. This idiopathic oligohydramnios is diagnosed when other causes are ruled out, and it's unclear why the amniotic fluid volume is low<sup>(25)</sup>.

### 1.5.8. Complications of post-date pregnancy

Post-date pregnancies are associated with increased risks for both the baby and the mother, including:

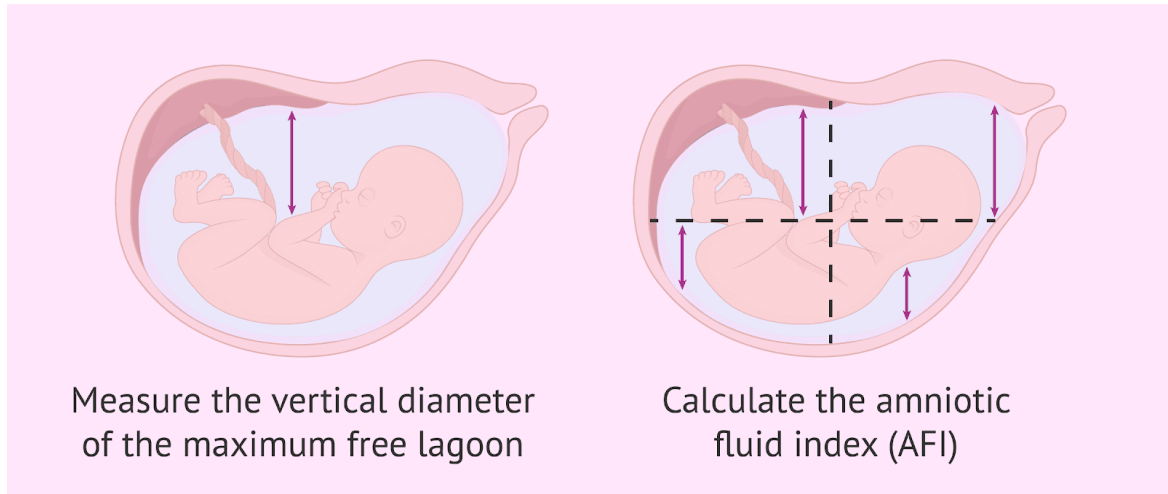
1. Placental Insufficiency: Leading to fetal distress and decreased oxygen supply.
2. Meconium Aspiration Syndrome: If the baby inhales meconium-stained amniotic fluid, leading to breathing problems at birth.
3. Abnormal growth of the fetus (for example, an abnormally large fetus or abnormally small fetus)
4. Stillbirth and Neonatal Death: The risks increase as the pregnancy progresses beyond term<sup>(25)</sup>.
5. Difficult labor due to shoulder dystocia
6. The need for cesarean delivery or operative vaginal delivery (with forceps or a vacuum extractor)
7. oligohydramnios
8. Problems with blood flow to the fetus, depriving the fetus or newborn of oxygen.
9. Admission to neonatal intensive care unit
10. postpartum hemorrhage<sup>(27)</sup>.

## 1.6. Manifestations of disease

### 1.6.1. Clinical Presentation and diagnosis of oligohydramnios

Most cases of oligohydramnios are discovered through normal ultrasonography (US) screenings. Clinical suspicion is warranted<sup>(28)</sup>.

if the patient reports vaginal bleeding or if their fundal height is unusually low for their age. Common diagnostic techniques for membrane rupture include sterile speculum inspection (for fluid that is nitrazine positive in nitrazine test and exhibits ferning in ferning test ) and tests that find a protein marker of amniotic fluid in the vagina<sup>(29)</sup>. Amnioinfusion with indigo carmine dye under ultrasound supervision, followed by monitoring for the presence of blue fluid flowing from the cervix, can be used to diagnose membrane rupture if other tests are equivocal. Due to significant shortages of indigo carmine and the absence of a workable substitute, the "amnio-dye test," long used to confirm ruptured membranes, has become ineffective<sup>(30)</sup>. Methods of Imaging and Results  
Ultrasound, tools like the amniotic fluid index (AFI) and the single-pocket assessment have been employed in ultrasound for semi quantitative measurements of amniotic fluid<sup>(31)</sup>. The patient is in a supine position, and the transducer is maintained at right angles to the maternal coronal plane in the sagittal plane. AFI is the total of the fluid levels in the four quadrants between the maternal midline vertically and a transverse line midway between the pubic symphysis and the uterine fundus, omitting the fetal components and the umbilical cord. The single deepest pocket (SDP) is the deepest point in a fluid as in Figure 0-4<sup>(31)</sup>.



**Figure 0-4: Measurement of amniotic fluid quantity<sup>(32)</sup>.**

### 1.7. Investigation for different causes of oligohydrominas (for different cases)

1. speculum examination (nitrazine test).
2. A plane ultrasound scan may be useful for assessing the oligohydrominas as in Figure 0-5.
3. Doppler assessment is recommended in the case of a fetus with suspected placental insufficiency-related oligohydramnios, especially in the presence of growth restriction<sup>(33)</sup>.
4. MRI may be of assistance in cases where oligohydramnios prevents proper US visualization<sup>(34)</sup>.



**Figure 0-5: post-date fetus with oligohydramnios<sup>(35)</sup>.**

## 1.8. General Management of oligohydramnios

1-The cause and gestational age of the pregnancy are key factors in determining how to treat oligohydramnios. Certain potentially fatal diseases, such as bilateral renal agenesis and autosomal recessive polycystic kidney disease, should prompt a discussion about abortion<sup>(36)</sup>.

2-Due to the potential for uteroplacental insufficiency, individuals with unexplained oligohydramnios in the second trimester should undergo serial fetal growth monitoring<sup>(37)</sup>.

3-There is a correlation between oligohydramnios and increased perinatal morbidity and mortality, thus antepartum testing that involves assessment of fluid (biophysical profile or modified biophysical profile) is also warranted.

4-Doppler examination improves the sensitivity for detecting poor perinatal outcomes in cases of suspected uteroplacental insufficiency<sup>(38)</sup>. The clinical situation should determine the testing frequency.

5-When PPRM is the cause of oligohydramnios, delivery should take place after 34 weeks of pregnancy. While closely monitoring for chorioamnionitis, preterm labor, placental abruption, or evidence of umbilical cord compression, preterm delivery can be avoided before 34 weeks with the help of steroids to speed up fetal lung maturation, latency antibiotics, and, in some cases, magnesium sulfate neuroprophylaxis.

6- In cases of category 2 fetal heart rate tracings, transcervical amnioinfusion has been demonstrated to minimize decelerations and the risk of cesarean section. Although transabdominal amnioinfusion has shown promise in improving perinatal outcomes following second-trimester spontaneous or iatrogenic PPRM (following amniocentesis or fetal surgery), it is not yet widely used. Treatment after delivery for oligohydramnios must take into account its underlying cause<sup>(39)</sup>.

## 1.9. Management of oligohydramnios in post-date pregnancy

### 1.9.1. Non stress test.

The non-stress test (NST) is a widely utilized, non-invasive procedure carried out during pregnancy to assess the baby's health. It is particularly beneficial in high-risk pregnancies or in conditions such as oligohydramnios, where monitoring the fetus's wellbeing becomes crucial<sup>(40)</sup>.

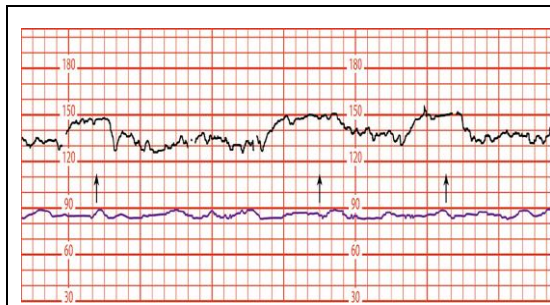
Fetal health is evaluated with the help of electronic fetal monitors, which record the fetus's heart rate constantly, during the Non-Stress Test (NST), which is performed at or more than 32 weeks of pregnancy (FHR). Fetal risk for intrauterine death or newborn problems can be assessed with this test, which is typically administered in high-risk pregnancies or when fetal hypoxemia is suspected. The test is commonly used since it is non-invasive and has a low risk to both the mother and the unborn child, but it is of low predictive value and can only be used to detect fetal hypoxemia at the time of administration<sup>(41)</sup>.

The NST entails 20 minutes of FHR monitoring, during which time the number, amplitude, and duration of accelerations that are commonly associated with fetal movement are evaluated. Two or more accelerations peaking at 15 bpm or more over baseline, lasting 15 seconds or more, happening within 20 minutes of starting the test, are considered typical by the American College of Obstetricians and Gynecologists. It's crucial to remember that even if non stress test comes back abnormal, it doesn't necessarily mean anything is wrong with your sleeping baby. Monitoring fetal heart rate (FHR) for at least 40 minutes to account for the fetus sleep cycle and using vibroacoustic stimulation to promote fetal activity may be necessary if a test is not responding. A biophysical profile or contraction stress test is typically recommended for additional assessment after a bioreactive nonreactive NST has been shown to indicate central nervous system depression<sup>(42)</sup>.

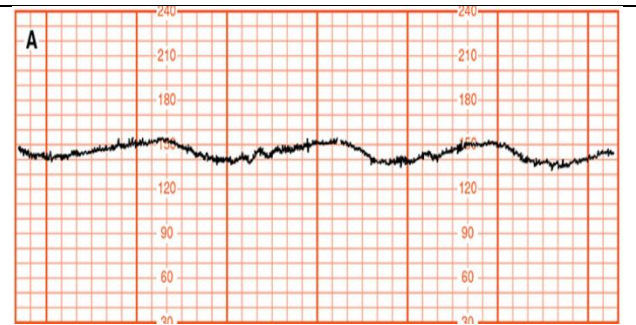
Due to the immaturity of the fetal heart, NSTs have a variable diagnostic value and a significant false-positive rate in pregnancies that are less than 32 weeks.

Pregnancies affected by oligohydramnios typically require more frequent NSTs to keep a close eye on the baby's health and allow for prompt intervention if necessary. The test, in conjunction with

other diagnostic instruments and clinical evaluations, helps medical staff make educated decisions about the treatment of the mother and child in these circumstances<sup>(43)</sup>.



**Figure 0-6: Reactive NST<sup>(44)</sup>.**



**Figure 0-7: Non-reactive NST<sup>(44)</sup>.**

### 1.9.2. Doppler changes in oligohydrominias

Doppler velocimetry is a fast, non-invasive method that helps doctors monitor and care for high-risk pregnancies by providing important information about the fetus' hemodynamic state<sup>(45)</sup>.

Doppler studies of the umbilical artery (UA) and middle cerebral artery (MCA) provide useful information for diagnosing hemodynamic changes happening in response to fetal hypoxia and anemia because of the data they provide about perfusion of the fetoplacental circulation and specific fetal organs<sup>(31)</sup>. It is important for clinicians to be aware of fetal circulation changes over time. Doppler indices, such as resistive indices (RI) and pulsatility indices (PI), have been frequently utilized to assess the UA and MCA. UA end diastolic flow can be assessed from 14 week of gestation onward and the middle cerebral artery (MCA) which can be assessed after 20 week and if abnormal repeat every 2 weeks but after 35 week has a high false positive rate <sup>(46)</sup> (Figure 0-10). Delivery as soon as fetal maturity is reached is the best option when there is a simultaneous shift in uterine and fetal cerebral waveforms. However, when both arteries show normal waveforms, fetal distress is unlikely (less than 4%), hence expectant care is recommended<sup>(47)</sup>. The prenatal morbidity and fetal mortality associated with oligohydramnios can be greatly reduced with early detection and care. In situations of oligohydramnios, the MCA and UA Doppler indices are extremely helpful in determining the health of the fetuses shown in figure 1-8. In situations of oligohydramnios, Doppler indices can be used to assess the fetal condition and guide clinical therapy<sup>(45)</sup>.

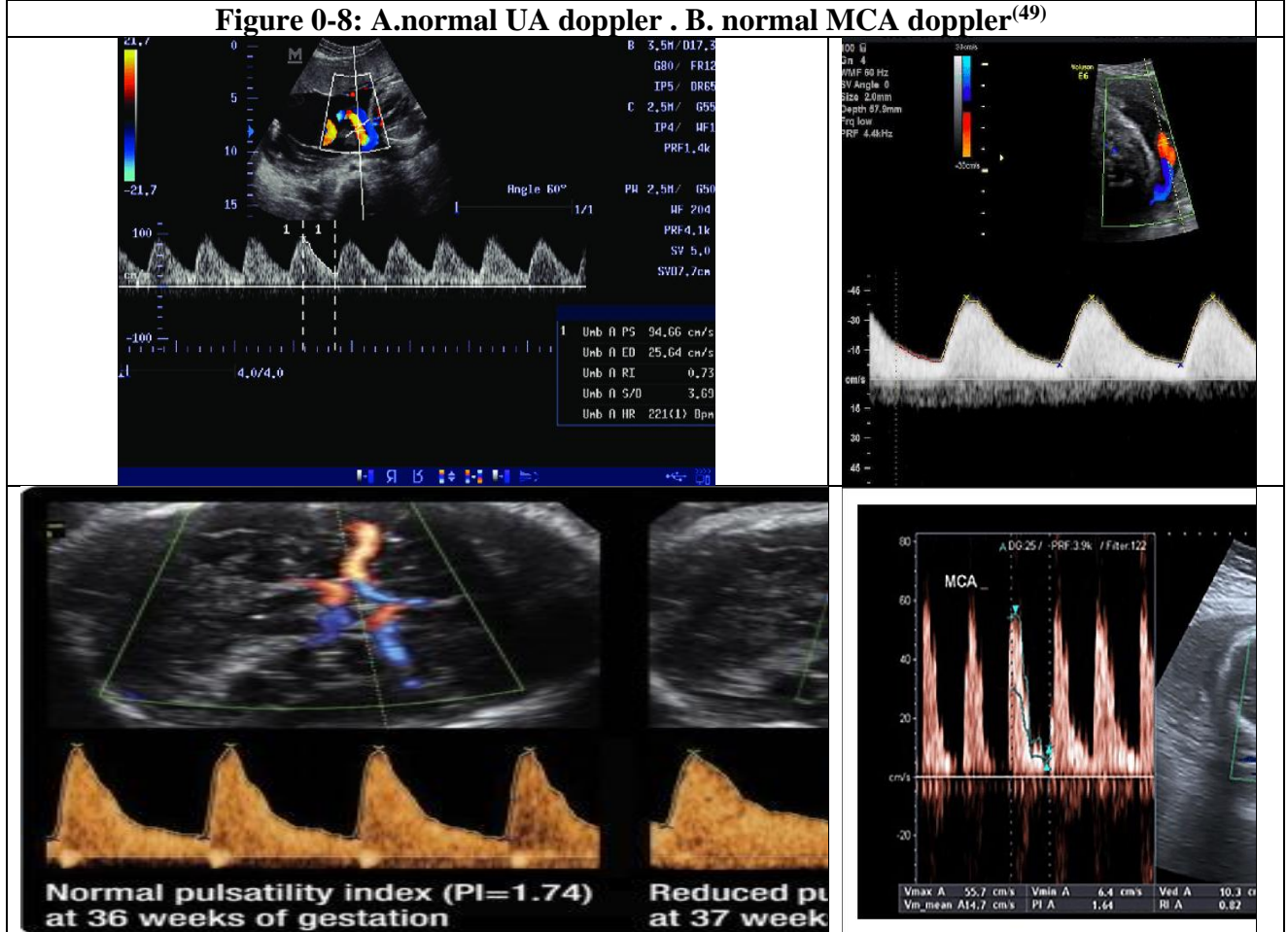
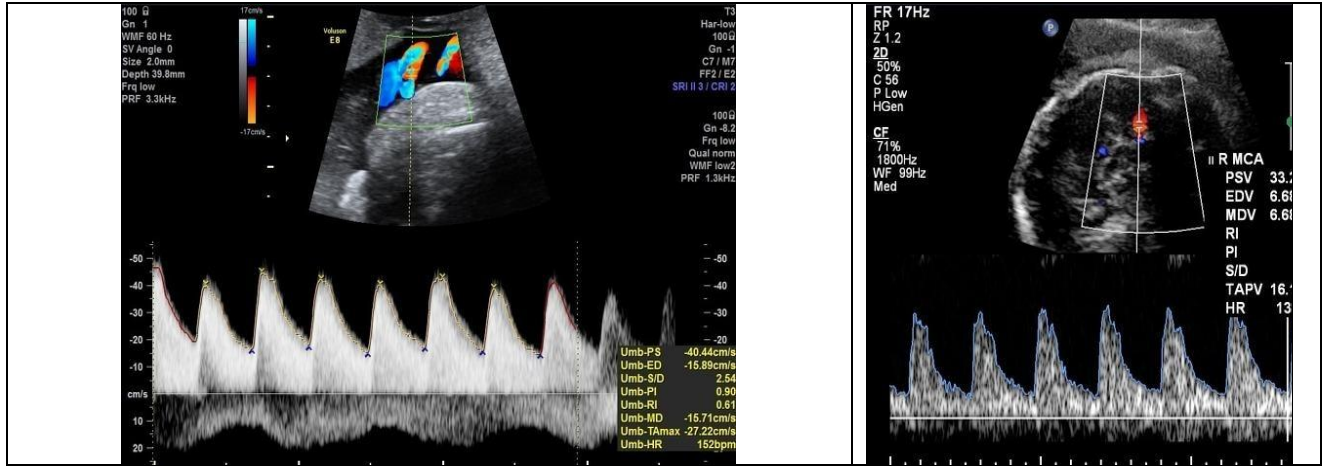
#### Normal value of umbilical artery and MCA doppler<sup>(48, 49)</sup>:

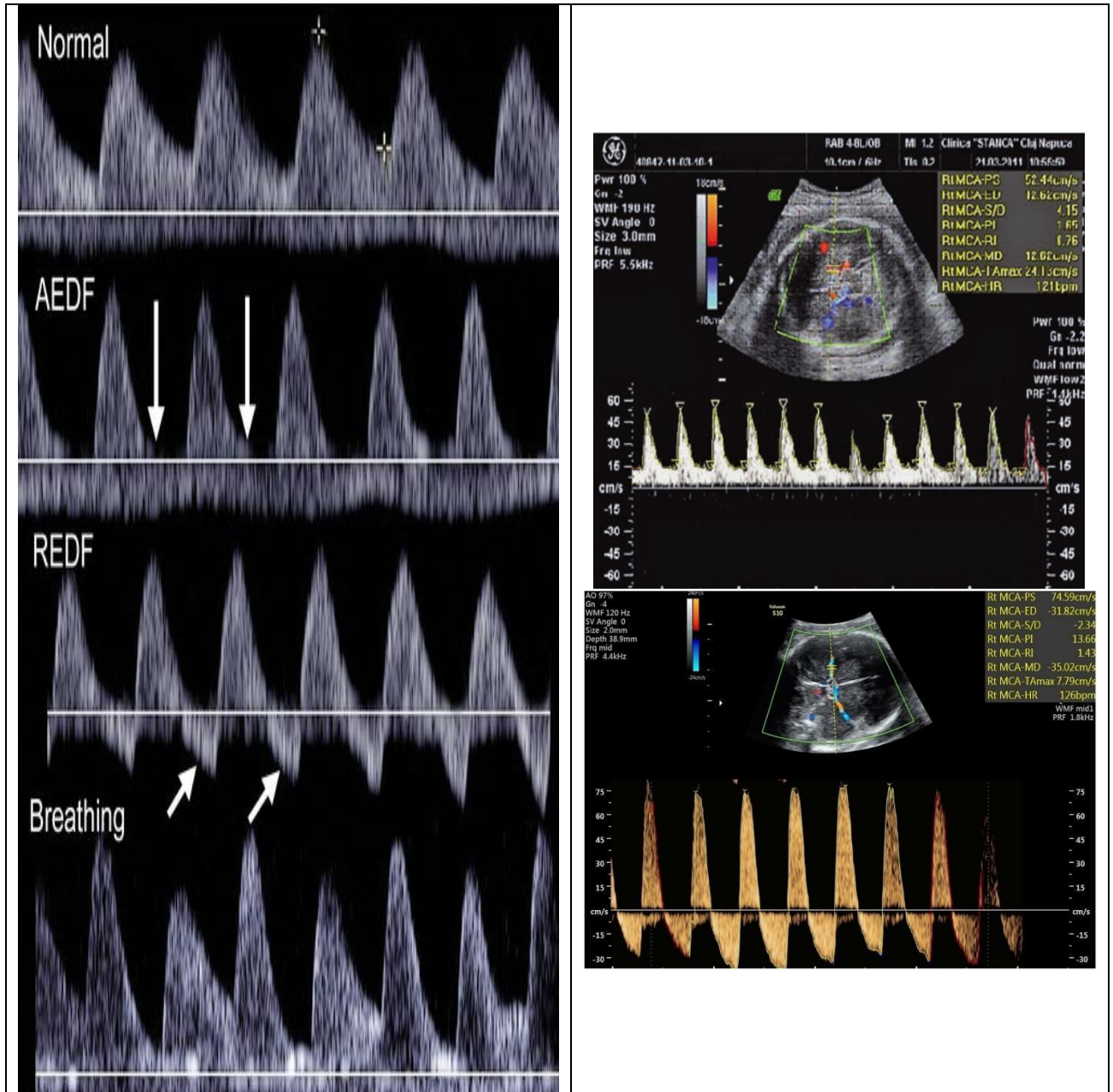
1. S/D ratio in 1<sup>st</sup> and 2<sup>nd</sup> trimester 3.3-4.3 with average 3.9
2. S/D ratio in 3<sup>rd</sup> trimester is 1.7-2.4 with average 2.1
3. Normal UA PI is  $1.84 \pm 0.55$  in 1<sup>st</sup> trimester,  $1.07 \pm 0.38$  in 2<sup>nd</sup> trimester, 0.78-0.23 in 3<sup>rd</sup> trimester. And mean PI of UA is 0.8 (32-37 weeks maximum sensitivity and specificity).
4. Normal UA RI  $0.53 \pm 0.18$  (in the second trimester) and  $0.48 \pm 0.20$  (in the third trimester), UA RI at 28-32 weeks had maximum sensitivity and UA RI at 32-37 weeks had maximum specificity.
5. Mean MCA PI is 1.3
6. Normal MCA RI is 0.62
7. S/D ratio of MCA > UA
8. S/D ratio of MCA at 20 week is 0.48.
9. S/D ratio of MCA at 37 week is 0.18.

#### Feature of abnormal doppler study <sup>(49, 50)</sup>

1. high UA artery PI
2. UA RI greater than 0.55 with bilateral notches

3. lowest ut artery PI less than 1.1
4. persistence of diastolic notch (unilateral or bilateral) after 23 week of gestation (abnormal ut. Art. Doppler).
5. High MCA RI
6. low MCA PI
7. increase S/D ratio  $> 2$  SD above the mean for the gestational age.





**Figure 0-10: Doppler studies<sup>(51)</sup>.**

A. Doppler studies of the UA showing normal, absent and reversed end diastolic flow. B. abnormal MCA doppler showing brain sparing effect . C. reversed end diastolic flow in MCA.

**1.10. The aim of the study**

To compare the value of fetal doppler ultrasound and fetal non-stress test in prediction of perinatal outcome in pregnant with oligohydramnios at post date pregnancy.

**Chapter two**

**Patients & methods**

**2. PATIENTS AND METHODS**

**1.11. Study Design, Setting and Data Collection Time**

This was a cohort study that was conducted in the Department of Obstetrics and Gynecology at Al-Elwiya Maternity Teaching Hospital during a period extended from 1st of January 2023 to 1st of December 2023.

### 1.12. Study patients and sample size

The study included 100 women who presented to outpatient clinic at Al-Elwiya Maternity Teaching Hospital.

### 1.13. Inclusion criteria

- ✓ Post –date Pregnant women with documented oligohydramnios.

### 1.14. Exclusion criteria:

- ✓ Patients with medical illness(pre eclampsia,chronic and gestational diabetes).
- ✓ Post-date with active phase of labor.
- ✓ Obstetrical indication for c section other than oligohydrominas.
- ✓ Women without oligohydramnios.
- ✓ Refusal to participate.
- ✓ APH (antepartum hemorrhage)

### 1.15. Ethical considerations and official approvals

Prior to gathering data, each patient gave their verbal consent, and the information was anonymized. Names were deleted, and identifying numbers were used instead. Every piece of information is kept private on a laptop with a password, and the data is only utilized for study.

The Council of Iraqi Board of Medical Specialization gave its permission. Al-Elwiya Maternity Teaching Hospital's Department of Obstetrics and Gynecology's approval and agreement were obtained.

### 1.16. Data collection:

The following information were gathered from each participant:

**Demographics:** The participants' demographic information, such as age and socioeconomic level, was collected. The study also kept track of a woman's gravidity, parity, history of miscarriages(last menstrual period thenEDD), and gestational age at the time of the study. Asking the patient about early current pregnancy ultrasound. Both initial participant interviews and patient records were used to get this data.

**Past History:** The individuals' prior obstetrical and medical histories were collected. This included details about any previous pregnancies and how they turned out, as well as any relevant health issues the mother may have had.

**Examination:** A standard physical examination was conducted on each participant. This included measurements such as weight and blood pressure, as well as an examination of the pregnant abdomen to assess fundal height, fetal lie, weight, and heart rate.

**Investigations:** Additional investigations relevant to the study were carried out. Laboratory tests, for instance, were performed to evaluate the mother's general health and look for any potential issues.

**Plain Ultrasound Findings:** Each participant underwent plain Ultrasound (using Canon Xario 200G) to assess AFI&SDP.

**Doppler Ultrasound Findings:** Each participant underwent a Doppler ultrasonography (using Canon Xario 200G) to assess the blood flow in the brain and umbilical cord. In the form of resistive indices (RI) and pulsatility indices (PI) of umbilical artery (UA) and middle cerebral artery (MCA). All observations were noted, including any anomalies or concerns.

**Non-Stress Test:** A non-stress test was conducted (using PHILIPS Avalon FM30) on each participant to monitor the fetal heart rate changes in response to its movements. All findings were recorded.

### Reporting Perinatal Outcome:

- **Maternal Outcome:** Data was collected on the mother's outcomes following the birth. This included the type of delivery (spontaneous vaginal, instrumental, or cesarean section, and whether the cesarean section was emergency or planned), any maternal complications during or after the delivery (such as hemorrhage, infection, or the need for further surgical interventions), and the length of the hospital stay.
- **Neonatal Outcome:** Data was collected on the newborn's outcomes. This included Apgar scores at 1 and 5 minutes, birth weight, any immediate complications (such as respiratory distress or need for resuscitation), neonatal morbidity and mortality rates, and whether neonatal intensive care unit admission was necessary. The duration of any required NICU stay was also recorded.

#### 1.17. Statistical analysis

Statistical Package for Social Sciences (SPSS) version 26 was used to analyze the data. The ranges, the standard deviation, and the mean of the data. Presenting categorical data as frequencies and percentages. Two-tailed Anova was performed. Chi Square test for categorical data. P value less than 0.05 considered statistically significant.

### Chapter three

#### Results

### 3. RESULTS

In the assessment of perinatal outcomes at post-date pregnancy associated with oligohydramnios, the study delineated four distinct groups based on the results of Non-Stress Tests (NST) and Doppler studies. Group 1, which represented individuals with reactive NST and normal Doppler findings, comprised 32% of the study population, totaling 32 subjects. Group 2 included those with normal NST results but abnormal Doppler readings, accounting for 26% of the cohort, with 26 subjects. Group 3 was characterized by abnormal NST results paired with normal Doppler studies, encompassing 30% of the participants, which corresponded to 30 individuals. Finally, Group 4, the smallest group, included subjects with both NST and Doppler results deviating from the norm, making up 12% of the population with a count of 12. These divisions underline the variability in testing outcomes within the context of oligohydramnios in post-date pregnancies and suggest a spectrum of perinatal risk profiles, (Figure 0-1).

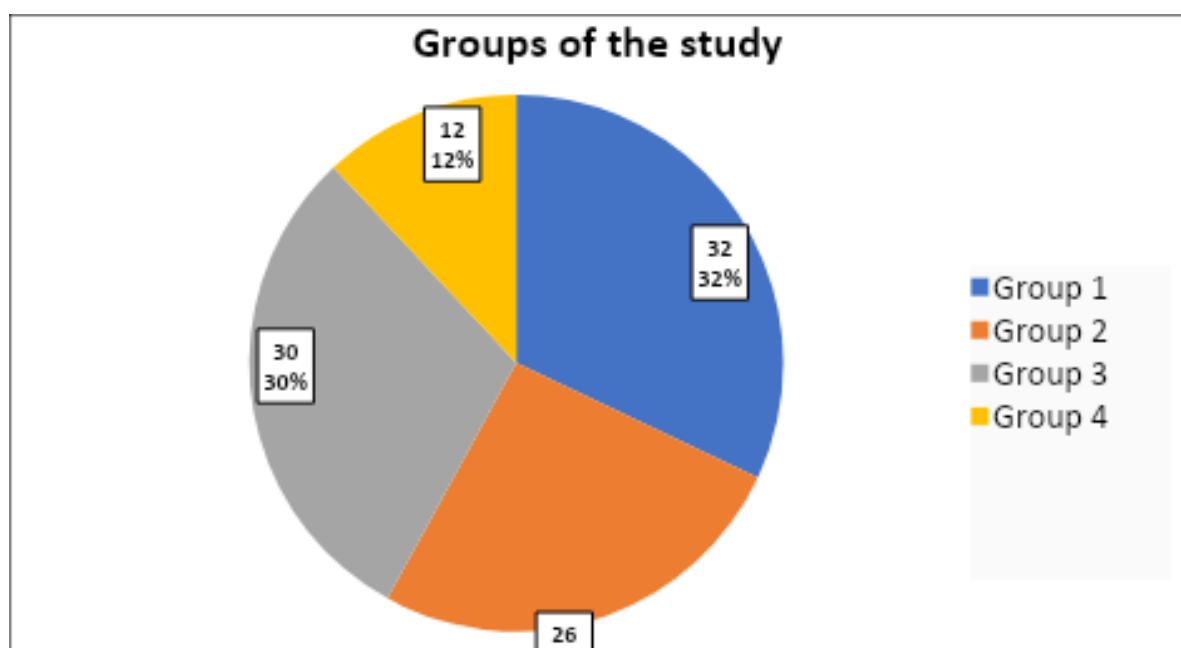


Figure 0-1: Distribution of the study groups.

The demographic characteristics of the subjects were closely examined across the four groups. In terms of age distribution, the youngest cohort (<20 years) was relatively evenly distributed among Groups 1 through 3, but Group 4 had a slightly higher percentage (25%). The 20-30 years age group formed the largest proportion of Groups 1, 2, and 3, with percentages ranging from 42.3% to 56.7%, but was less represented in Group 4 at 25%. Individuals over 30 years were most prevalent in Group 4 (50%), followed by Groups 1 and 2 (both 40.6%), and least in Group 3 (36.7%). However, statistical analysis indicated no significant difference in age distribution across the groups ( $P=0.583$ ), (Table 0-1).

Regarding BMI, those in the normal range (18.5-24.9) were least represented in Group 1 and most represented in Group 2. The overweight category (25-29.9) was most prevalent in Groups 1 and 2, while the obese category ( $\geq 30$ ) saw a higher percentage in Group 3 (50%). The mean BMI was slightly higher in Group 3 compared to the other groups, yet these differences were not statistically significant ( $P=0.157$ ), (Table 0-1).

Parity was also considered, with primiparas (first-time mothers) and multiparas (mothers who have given birth more than once) spread across all groups. Group 3 had the highest percentage of primiparas, while Group 2 had the highest for para 2. High parity (para 4) was most common in Group 4. Despite these variations, parity did not show a significant difference across the groups ( $P=0.96$ ), (Table 0-1).

Overall, while there were observable trends in age, BMI, and parity across the groups, statistical analysis showed that these were not significant contributors to the differences in NST and Doppler outcomes in this study, (Table 0-1).

**Table 0-1: Distribution of participants demographics.**

Variables		Group 1	Group 2	Group 3	Group 4	P value
		No. (%)	No. (%)	No. (%)	No. (%)	
Age group	<20 years	5 (15.6)	4 (15.4)	2 (6.7)	3 (25)	0.583
	20-30 years	14 (43.8)	11 (42.3)	17 (56.7)	3 (25)	
	>30 years	13 (40.6)	11 (42.3)	11 (36.7)	6 (50)	
	Mean $\pm$ SD	27.66 $\pm$ 7.05	26.46 $\pm$ 7.24	27.27 $\pm$ 5.69	26.83 $\pm$ 8.01	0.925
BMI group	18.5-24.9	6 (18.8)	9 (34.6)	6 (20)	4 (33.3)	0.071
	25-29.9	17 (53.1)	14 (53.8)	9 (30)	5 (41.7)	
	$\geq 30$	9 (28.1)	3 (11.5)	15 (50)	3 (25)	
	Mean $\pm$ SD	27.82 $\pm$ 2.7	26.48 $\pm$ 2.89	28.13 $\pm$ 3.05	26.98 $\pm$ 3.16	0.157
Parity	Primi	5 (15.6)	5 (19.2)	7 (23.3)	2 (16.7)	0.960
	Para 1	6 (18.8)	4 (15.4)	6 (20)	3 (25)	
	Para 2	7 (21.9)	9 (34.6)	9 (30)	2 (16.7)	
	Para 3	7 (21.9)	5 (19.2)	5 (16.7)	2 (16.7)	
	Para 4	7 (21.9)	3 (11.5)	3 (10)	3 (25)	

The study further investigated the mode of delivery across the different groups. Group 1 favored vaginal delivery, with a significant majority (87.5%) delivering vaginally and only a small fraction (12.5%) undergoing cesarean sections. In contrast, Group 2 had the highest rate of cesarean deliveries, at 76.9%, with vaginal deliveries accounting for 23.1%. Group 3 also had a majority of cesarean deliveries (60%), but not as pronounced as Group 2. Group 4 had marked rate of C/S (66.7%), with vaginal deliveries at 33.3%. The statistical analysis revealed that the mode of delivery was significantly associated with the group classifications ( $P < 0.0001$ ), indicating that NST and Doppler findings may be influential in determining the mode of delivery, (Table 0-2).

**Table 0-2: distribution of maternal outcome according to the groups of the study.**

Variables		Group 1	Group 2	Group 3	Group 4	P value
		No. (%)	No. (%)	No. (%)	No. (%)	
Mode of delivery	Caesarean	4 (12.5)	20 (76.9)	18 (60)	8 (66.7)	<0.0001
	Vaginal	28 (87.5)	6 (23.1)	12 (40)	4 (33.3)	

The rate of NICU admissions varied significantly among the groups. Group 1 had the lowest NICU admission rate at 3.1%. In contrast, Group 4 exhibit the highest rate of NICU admission at 83.3% followed by Group2 with 76.9%. Group 3 maintained a lower rate at 16.7%. The variation in NICU admission rates was also statistically significant ( $P < 0.0001$ ), suggesting a strong association between the NST and Doppler findings of each group and the likelihood of NICU admission, (Table 0-3).

These results highlight the importance of NST and Doppler evaluations in predicting adverse perinatal outcomes, with particular emphasis on the elevated risks associated with Groups 2 and 4, (Table 0-3).

**Table 0-3: Distribution of neonatal outcome according to the groups of the study.**

Variables		Group 1	Group 2	Group 3	Group 4	P value
		No. (%)	No. (%)	No. (%)	No. (%)	
NICU	Yes	1 (3.1)	20 (76.9)	5 (16.7)	10 (83.3)	<0.0001
	No	31 (96.9)	6 (23.1)	25 (83.3)	2 (16.7)	

The Apgar scores, which assess the immediate postnatal condition of the newborns, were significantly different across the four study groups. For Apgar score (Apgar1), taken one-minute post-birth, Group 1 had the highest mean score of 6.66 with a standard deviation (SD) of  $\pm 1.23$ . Group 3 had a slightly lower mean score of 5.92 (SD  $\pm 1.32$ ), and Group 2 had the lowest mean score of all the groups at 5.13 (SD  $\pm 1.2$ ). Group 4 had a mean score of 6 (SD  $\pm 1.41$ ). These differences were statistically significant with a P value of less than 0.0001, indicating a strong association between NST and Doppler findings and the initial Apgar score at 1 minute, (Table 0-4).

Apgar score at 5 minutes, assessed at five minutes after birth, followed a similar trend. Group 1 again had the highest mean score of 8 (SD  $\pm 1.55$ ), while Group 3 had a mean of 7.04 (SD  $\pm 1.61$ ), and Group 2 had a mean of 6.33 (SD  $\pm 1.24$ ). Group 4 had a mean Apgar2 score of 6 (SD  $\pm 1.41$ ). The P value for the second Apgar score was also less than 0.0001, confirming significant differences between the groups, (Table 0-4).

These Apgar scores at 1 minute suggest that newborns from Group 1, with reactive NST and normal Doppler, had a more favorable immediate postnatal condition compared to the other groups. Group 2, characterized by abnormal Doppler, had the lowest Apgar scores, potentially reflecting more significant perinatal stress. While after 5 minutes the lowest Apgar score was reported in cases with abnormal both doppler and NST studies, (Table 0-4).

**Table 0-4: Distribution of Apgar score according to the groups of the study.**

Variables	Group 1	Group 2	Group 3	Group 4	P value
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	
Apgar 1	6.66 $\pm$ 1.23	5.13 $\pm$ 1.2	5.92 $\pm$ 1.32	6 $\pm$ 1.41	<0.0001
Apgar 5	8 $\pm$ 1.55	6.33 $\pm$ 1.24	7.04 $\pm$ 1.61	6 $\pm$ 1.41	<0.0001

The data regarding the role of Non-Stress Test (NST), Doppler studies, and combined testing in predicting the need for NICU admission reveal distinct strengths and weaknesses for each method. Doppler studies stand out with an impressive sensitivity of 83.3%, indicating a high capability for correctly identifying infants who will require NICU care. This makes Doppler particularly informative for early intervention, as it ensures that most infants in need are identified. Its high

positive predictive value (PPV) of 78.9% also suggests that a significant majority of the positive test results are true positives, indicating a reliable test for anticipating NICU admissions, (Table 0-5).

On the other hand, the combined testing strategy boasts the highest specificity at 96.9%, which is critical for reducing the likelihood of false positives — in other words, it accurately identifies most infants who will not require NICU care. Its PPV is equal to that of Doppler alone, suggesting that when combined testing indicates a need for NICU admission, the prediction is highly reliable, (Table 0-5).

While the NST alone shows lower sensitivity and specificity compared to Doppler and combined testing, its value cannot be disregarded. It has a moderate negative predictive value (NPV) of 63.8% and the lowest accuracy at 52%, which indicates a relatively higher chance of missing infants who might need NICU care and misclassifying those who do not, (Table 0-5).

In terms of overall informativeness for predicting NICU admission, Doppler studies are the most reliable single test, evidenced by their high sensitivity and accuracy. However, the combined approach, while less sensitive, provides a high degree of certainty in its predictions, as shown by its high specificity and PPV. This suggests that using a combined approach may be the most prudent strategy in clinical settings where it is crucial to minimize both false positives and false negatives. The combination of NST and Doppler studies can complement each other, potentially offering a balanced and comprehensive assessment to inform clinical decision-making regarding NICU admissions, (Table 0-5).

**Table 0-5: The role of NST, doppler tests separately and combined in prediction of need of NICU admission.**

Parameters	NST	Doppler	Combined
Sensitivity (%)	41.7	83.3	27.8
Specificity (%)	57.8	87.5	96.9
Positive predictive value (%)	35.7	78.9	83.3
Negative predictive value (%)	63.8	90.3	70.5
Accuracy (%)	52	86	72

## Chapter four

### Discussion

#### 3. DISCUSSION

The current study had four clearly separate groups by utilizing the outcomes of NST and Doppler investigations (in 100 post-date pregnant women). This distinction was essential to comprehending the range of prenatal hazards connected to oligohydramnios. Notably, our study showed that groups with abnormal results—whether from the Doppler, NST, or both—were substantially more likely to have elevated hazards, such as higher rates of cesarean sections and NICU admissions.

The current study was homogeneously distributed in regard to the maternal age, BMI, and parity. With no statistical difference among these variables, thus eliminating the effect of these factors on the final outcomes.

It is worth noting that previous studies showed that: advancing maternal age, higher BMI, and parity associated with adverse maternal and fetal outcomes as suggested by Glick et al<sup>(52)</sup>, Snehlata et al<sup>(53)</sup>, and Eugene et al<sup>(54)</sup> respectively.

Regarding mode of delivery, cases of abnormal doppler study was associated with the highest rate of C/S, next to it was cases with combined abnormal doppler and NST studies, and finally were cases of abnormal NST. These findings suggest that doppler study had higher association with the prediction of the requirement of C/S. Subramanian et al<sup>(55)</sup> found that cases of isolated doppler abnormality were associated with higher rate of C/S.

This stratification aligns with the intrinsic diagnostic capabilities of these modalities. Doppler ultrasound, with its focus on fetal hemodynamics, particularly the umbilical artery, cerebral arteries, and ductus venosus, provides a critical assessment of placental insufficiency and fetal hypoxia as suggested by Meler et al<sup>(56)</sup>. These conditions, often undetectable by NST as suggested by Baschat et al<sup>(57)</sup>, are well-documented precursors to adverse perinatal outcomes, necessitating a more interventional approach, often culminating in C/S. Contrastingly, NST, though valuable, primarily offers insight into short-term fetal reactivity and heart rate patterns, which, while indicative of acute fetal distress, may not singularly warrant immediate surgical intervention. Such findings underscore the imperative role of Doppler in not just surveillance but also in guiding the mode of delivery, reflecting its sensitivity in detecting clinically significant pathophysiologies that necessitate a C/S for optimal perinatal outcomes<sup>(58)</sup>.

The Apgar scores at 1 minute indicating that newborns from Group 1, with reactive NST and normal Doppler, had a more favorable immediate post natal condition compared to other groups, align with recent findings. This outcome can be attributed to the fact that reactive NST and normal Doppler studies are generally associated with better fetal oxygenation and less distress, leading to higher Apgar scores. In contrast, Group 2, characterized by abnormal Doppler, had the lowest Apgar scores, potentially reflecting more significant perinatal stress. This is consistent with research suggesting that abnormal Doppler findings, indicative of compromised fetal blood flow, can be a predictor of adverse neonatal outcomes Saber et al<sup>(59)</sup>. After 5 minutes, the lowest Apgar score was reported in cases with abnormal both Doppler and NST studies. This further substantiates the critical nature of combined fetal monitoring in predicting and managing perinatal risks. Abnormal findings in both tests indicate a heightened risk for perinatal asphyxia and other complications, leading to lower Apgar scores at 5 minutes Mughal et al<sup>(60)</sup>.

The data regarding the role of Non-Stress Test (NST), Doppler studies, and combined testing in predicting the need for NICU admission reveal distinct strengths and weaknesses for each method. Doppler studies stand out with an impressive sensitivity of 83.3%, indicating a high capability for correctly identifying infants who will require NICU care, Singh et al<sup>(61)</sup> found the sensitivity of doppler study to be 71.42% while NST only 25%. This makes Doppler particularly informative for early intervention, as it ensures that most infants in need are identified. Its high positive predictive value (PPV) of 78.9% also suggests that a significant majority of the positive test results are true positives, indicating a reliable test for anticipating NICU admissions, Robindro et al<sup>(62)</sup> found that PPV of doppler study to be 78.12% while NST 69.23%, while in the current study the PPV of NST was 35.7%.

On the other hand, the combined testing strategy boasts the highest specificity at 96.9%, which is critical for reducing the likelihood of false positives — in other words, it accurately identifies most infants who will not require NICU care. Its PPV is more than Doppler alone, suggesting that when combined testing indicates a need for NICU admission, the prediction is highly reliable. This relationship was poorly investigated by previous studies making this finding novel in the current study.

While the NST alone shows lower sensitivity and specificity compared to Doppler and combined testing, its value cannot be disregarded. It has a moderate negative predictive value (NPV) of 63.8% and the lowest accuracy at 52%, which indicates a relatively higher chance of missing infants who might need NICU care and misclassifying those who do not. While Anjum et al<sup>(63)</sup> found sensitivity of NST to be 72.34%, specificity of 60.38% PPV 61.82% and NPV of 71.11% although these values were higher from the current study yet it still not reaching to the level of standing alone as screening or diagnostic tool.

In terms of overall informativeness for predicting NICU admission, Doppler studies are the most reliable single test, evidenced by their high sensitivity and accuracy. However, the combined approach, while less sensitive, provides a high degree of certainty in its predictions, as shown by its high specificity and PPV. This suggests that using a combined approach may be the most prudent strategy in clinical settings where it is crucial to minimize both false positives and false negatives.

The combination of NST and Doppler studies can complement each other, potentially offering a balanced and comprehensive assessment to inform clinical decision-making regarding NICU admissions.

### **Chapter five**

#### **Conclusion & Recommendations**

#### **4. Conclusion**

- The study showed significant association of abnormal NST and abnormal doppler studies in increased rate of C/S(in post- date pregnancy).
- Doppler studies proved most reliable for predicting NICU admission with high sensitivity and positive predictive value. While NST alone showed lower efficacy. Combining NST and Doppler enhanced specificity, suggesting a balanced approach in clinical decision-making for NICU admissions is most effective(in post-date pregnancy).

#### **5. Recommendations**

- **Enhanced Monitoring Protocols:** Implement routine NST and Doppler evaluations in the management of post-date pregnancies, especially those complicated by oligohydramnios, to optimize perinatal outcomes.
- **Individualized Care Approaches:** Recognize the variability in outcomes associated with oligohydramnios and adapt individualized care plans accordingly.
- **Further Research:** Conduct larger, longitudinal studies with diverse cohorts to better understand the long-term implications of NST and Doppler findings in perinatal care.
- **Training and Awareness:** Increase training for healthcare providers in the interpretation and application of NST and Doppler results, emphasizing their importance in clinical decision-making.
- **Policy Development:** Develop and update clinical guidelines and policies to reflect the latest findings on the role of NST and Doppler in managing post-date pregnancies with oligohydramnios.
- **Patient Education:** Educate patients about the significance of NST and Doppler studies, particularly in high-risk pregnancies, to ensure informed participation in their healthcare decisions.

### **References**

#### **6. REFERENCES**

1. Figueroa L, McClure EM, Swanson J, Nathan R, Garces AL, Moore JL, et al. Oligohydramnios: a prospective study of fetal, neonatal and maternal outcomes in low-middle income countries. *Reproductive Health*. 2020;17(1):1-7.
2. Sudha D, Sinha K. Feto-maternal outcome in oligohydramnios in a tertiary care hospital: an observational study. *European Journal of Molecular & Clinical Medicine (EJMCM)*. 2020;7(10):2020.
3. Paliwal S, Shaheen R, Parakh P, Paliwal S, Yadar K, Chaudhany G. Comparative role of non-stress test and colour doppler in high risk pregnancy predicted by placental histopathology and foetal outcome. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*. 2017;6(4):1444-9.
4. Rabie N, Magann E, Steelman S, Ounpraseuth S. Oligohydramnios in complicated and uncomplicated pregnancy: a systematic review and meta-analysis. *Ultrasound in Obstetrics & Gynecology*. 2017;49(4):442-9.

5. Beall MH, van den Wijngaard JP, van Gemert M, Ross MG. Water flux and amniotic fluid volume: understanding fetal water flow. *Nephrology and Fluid/electrolyte Physiology*. 2019;3-18.
6. SharMa M, Bhagwani D, ChauraSia M, Jain P. Maternal and perinatal outcome in pregnancies with oligohydramnios in third trimester. *Indian J Neonatal Med Res*. 2016;4(3):0001-5.
7. Beall MH, Ross MG. Manipulation of amniotic fluid volume: homeostasis of fluid volumes in the amniotic cavity. *Fetal Therapy: Scientific Basis and Critical Appraisal of Clinical Benefits*. 2020:191.
8. Palermo MS, Espinosa A, Trasmonte M. Disorders of amniotic fluid volume: oligoamnios and polyhydramnios. *Perinatology: Evidence-Based Best Practices in Perinatal Medicine*: Springer; 2021. p. 687-705.
9. Bhatti G, Romero R, Gomez-Lopez N, Chaiworapongsa T, Jung E, Gotsch F, et al. The amniotic fluid proteome changes with gestational age in normal pregnancy: a cross-sectional study. *Scientific Reports*. 2022;12(1):1-16.
10. Jones CW, Tessier K, Raasch C, Dharampaul K. Very advanced maternal age and obstetric outcomes [40L]. *Obstetrics & Gynecology*. 2020;135:134S.
11. Goodlin R, Anderson J, Gallagher T. Relationship between amniotic fluid volume and maternal plasma volume expansion. *American Journal of Obstetrics and Gynecology*. 1983;146(5):505-11.
12. Ahmed AW, Abdul-QaderKhuder H, Abdulrahman DM. Evaluation Of Amniotic Fluid By Ultrasound In Oligohydromnia Managed By Oral Maternal Rehydration In 2nd And 3rd Trimesters In Mosul City. *Syst Rev Pharm*. 2020;11(12):1944-9.
13. Flack NJ, Sepulveda W, Bower S, Fisk NM. Acute maternal hydration in third-trimester oligohydramnios: effects on amniotic fluid volume, uteroplacental perfusion, and fetal blood flow and urine output. *American journal of obstetrics and gynecology*. 1995;173(4):1186-91.
14. Kiran S, Ameen A, Akram A, Jamil M. Comparison of effects of oral maternal hydration and intravenous infusions on Amniotic Fluid Index in third trimester isolated Oligohydramnios. *The Professional Medical Journal*. 2019;26(12):2064-9.
15. Chandra P, Schiavello H, Lewandowski M. Effect of oral and intravenous hydration on oligohydramnios. *The Journal of reproductive medicine*. 2000;45(4):337-40.
16. Malik M, Irshaad S, Bokhari NA, Qazi WA, Raza A, Bashir K. EFFECTS OF ORAL FLUIDS AND INTRAVENOUS FLUIDS IN THE IMPROVEMENT OF AMNIOTIC FLUID INDEX DURING THIRD TRIMESTER OF PREGNANCY. *Pakistan Armed Forces Medical Journal*. 2021;71(1):179-83.
17. Horsager R, Nathan L, Leveno KJ. Correlation of measured amniotic fluid volume and sonographic predictions of oligohydramnios. *Obstetrics and gynecology*. 1994;83(6):955-8.
18. Weiss E, Abele H, Bartz C, Franz M, Fischer T, Gembruch U, et al. S1-Guideline: Management of Late-term and Post-term Pregnancy: Short version - AWMF Registry Number: 015/065. *Geburtshilfe Frauenheilkd*. 2014;74(12):1099-103.
19. Smulian J, Quinones J. Post-term pregnancy. *Evidence-based Obstetrics and Gynecology*. 2019:431-9.
20. Galal M, Symonds I, Murray H, Petraglia F, Smith R. Postterm pregnancy. *Facts, views & vision in ObGyn*. 2012;4(3):175.
21. Phung J, Paul J, Smith R. Maintenance of pregnancy and parturition. *Maternal-fetal and neonatal endocrinology*: Elsevier; 2020. p. 169-87.

22. Lara-Barea A, Sánchez-Lechuga B, Campos-Caro A, Córdoba-Doña JA, de la Varga-Martínez R, Arroba AI, et al. Angiogenic Imbalance and Inflammatory Biomarkers in the Prediction of Hypertension as Well as Obstetric and Perinatal Complications in Women with Gestational Diabetes Mellitus. *J Clin Med.* 2022;11(6).
  23. F.Gary Cunningham KJL, Jodi S. Dashe, Barbara L Hoffman, Catherine Y, Spong, Brian M. Casey. postterm pregnancy. In: F.Gary Cunningham KJL, Jodi S. Dashe, Barbara L Hoffman, Catherine Y, Spong, Brian M. Casey, editor. Williams OBSTETRICS. 26: McGraw Hill; 2022.
  24. Mahendru AA, Wilhelm-Benartzi CS, Wilkinson IB, McEniery CM, Johnson S, Lees C. Gestational length assignment based on last menstrual period, first trimester crown-rump length, ovulation, and implantation timing. *Arch Gynecol Obstet.* 2016;294(4):867-76.
  25. Twesigomwe G, Migisha R, Agaba DC, Owaraganise A, Aheisibwe H, Tibaijuka L, et al. Prevalence and associated factors of oligohydramnios in pregnancies beyond 36 weeks of gestation at a tertiary hospital in southwestern Uganda. *BMC Pregnancy Childbirth.* 2022;22(1):610.
  26. Kacerovsky M, Musilova I, Andrys C, Drahosova M, Hornychova H, Rezac A, et al. Oligohydramnios in women with preterm prelabor rupture of membranes and adverse pregnancy and neonatal outcomes. *PLoS One.* 2014;9(8):e105882.
  27. Linder N, Hirsch L, Fridman E, Klinger G, Lubin D, Kouadio F, et al. Post-term pregnancy is an independent risk factor for neonatal morbidity even in low-risk singleton pregnancies. *Archives of Disease in Childhood-Fetal and Neonatal Edition.* 2015.
  28. Leytes S, Kovo M, Weiner E, Ganer Herman H. Isolated oligohydramnios in previous pregnancy is a risk factor for a placental related disorder in subsequent delivery. *BMC Pregnancy and Childbirth.* 2022;22(1):1-6.
- STANDARD AFPAG, PRON OD. PREMATURE RUPTURE OF MEMBRANES.
29. Kerns J, Amon E, Winn HN. Amnioinfusion. Clinical Maternal-Fetal Medicine Online: CRC Press; 2021. p. 69.1-.5.
  30. Dalal N, Malhotra A. Perinatal outcome in cases of severe oligohydramnios. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology.* 2019;8(4):1538-42.
  31. Zaira Salvador B.Sc MS. Amniotic Fluid Assessment 2022 [Available from: <https://www.invitro.com/en/amniotic-fluid/amniotic-fluid-assessment/>].
  32. Cho H. Does Fetal Pulmonary Venous Flow Impedance Increase in Pregnancies With Placental Insufficiency–Related Oligohydramnios in the Third Trimester? *Journal of Ultrasound in Medicine.* 2020;39(5):859-65.
  33. Wang S, Meng T, Zheng H. Application of B-Ultrasound Combined with Magnetic Resonance Imaging Information Monitoring in the Diagnosis of Premature Rupture of Membranes and Oligohydramnios. *Journal of Medical Imaging and Health Informatics.* 2021;11(2):654-9.
  34. Chauhan MB, Malik R. Postterm Pregnancy. In: Sharma A, editor. Labour Room Emergencies. Singapore: Springer Singapore; 2020. p. 173-81.
  35. Nath J, Chaube S, Rani N, Verma P. A study on sildenafil citrate in the treatment of IUGR & Oligohydramnios. *IGRWH.* 2020;3:431-5.
  36. Munn MB. Management of oligohydramnios in pregnancy. *Obstetrics and Gynecology Clinics.* 2011;38(2):387-95.
  37. Mandal A, Patra KK, Maity NK, Sen D. Intrauterine growth restriction and perinatal outcome among oligohydramnios pregnancies. *Asian Journal of Medical Sciences.* 2022;13(8):186-94.
  38. Ahmed B. Amnioinfusion in severe oligohydramnios with intact membrane: an observational study. *The Journal of Maternal-Fetal & Neonatal Medicine.* 2022;35(25):6518-21.

39. Nair RV, Bhutiyani A, Venetia A. A prospective study on correlation of non-stress test in high risk pregnancy at a tertiary care centre. 2020( Issue 1):26-9.
40. Sharma J, Goyal M. Cardiotocography and diabetic pregnancy. *J Pak Med Assoc.* 2016;66(9 Suppl 1):S30-3.
41. Campanile M, D'Alessandro P, Della Corte L, Saccone G, Tagliaferri S, Arduino B, et al. Intrapartum cardiotocography with and without computer analysis: a systematic review and meta-analysis of randomized controlled trials. *J Matern Fetal Neonatal Med.* 2020;33(13):2284-90.
42. Umana OD, Siccardi MA. Prenatal Nonstress Test. StatPearls. Treasure Island (FL) ineligible companies. Disclosure: Marco Siccardi declares no relevant financial relationships with ineligible companies.: StatPearls Publishing  
Copyright © 2023, StatPearls Publishing LLC.; 2023.
43. F.Gary Cunningham KJL, Jodi S. Dashe, Barbara L Hoffman, Catherine Y, Spong, Brian M. Casey. Antepartum Fetal Assessment. In: F.Gary Cunningham KJL, Jodi S. Dashe, Barbara L Hoffman, Catherine Y, Spong, Brian M. Casey, editor. Williams OBSTETRICS. 26: McGraw Hill; 2022.
44. Sanad ZF, Gaied AMA, Dawod RM, Mahmoud HS, Fahmy KN. Predictive value of fetal renal artery Doppler indices in idiopathic oligohydramnios and polyhydramnios. *Menoufia Medical Journal.* 2019;32(2):476.
45. Goyal AS, Goel S, Gupta M, Vaishnav G. Relationship between umbilical artery Doppler and perinatal outcomes in Indian women with oligohydramnios. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology.* 2016;5(4):1187-92.
46. Cırık DA, Taşkın EA, Karcaaltıncaba D, Dai Ö. Study of uterine and fetal hemodynamics in response to labor induction with dinoprostone in prolonged pregnancies with normal amniotic fluid and oligohydramnios. *The Journal of Maternal-Fetal & Neonatal Medicine.* 2014;27(7):691-5.
47. Umbilical Artery Doppler Reference Ranges: Perinatology.com; 2023 [updated 2023. Available from: <https://www.perinatology.com/calculators/umbilicalartery.htm>.
48. Mari G, Hanif F. Fetal Doppler: Umbilical Artery, Middle Cerebral Artery, and Venous System. *Seminars in Perinatology.* 2008;32(4):253-7.
49. Umbilical arterial Doppler assessment. *Radiopaedia.org.* 2023.
50. Mihiu D, Diculescu D, Costin N, Mihiu C, Blaga L, Ciortea R, et al. Applications of Doppler ultrasound during labor. *Medical ultrasonography.* 2011;13:141-9.
51. Glick I, Kadish E, Rottenstreich M. Management of pregnancy in women of advanced maternal age: Improving outcomes for mother and baby. *International journal of women's health.* 2021:751-9.
52. Snehlata, Sweta L. A study of Maternal BMI as Determinant of Pregnancy & Perinatal Outcomes in Hazaribagh Medical College and Hospital, Hazaribagh. *Obs Gyne Review: Journal of Obstetric and Gynecology.* 2021;7(1).
53. Eugene MI, Abedinego OA. Grandmultiparity: Is it really an independent predictor of adverse pregnancy outcomes? *Saudi Journal for Health Sciences.* 2017;6(2):77-82.
54. Subramanian V, Venkat J, Dhanapal M. Which is Superior, Doppler Velocimetry or Non-stress Test or Both in Predicting the Perinatal Outcome of High-Risk Pregnancies. *The Journal of Obstetrics and Gynecology of India.* 2016;66(S1):149-56.
55. Meler E, Martínez J, Boada D, Mazarico E, Figueras F. Doppler studies of placental function. *Placenta.* 2021;108:91-6.

56. Baschat AA, Galan HL, Lee W, DeVore GR, Mari G, Hobbins J, et al. The role of the fetal biophysical profile in the management of fetal growth restriction. *American Journal of Obstetrics and Gynecology*. 2022;226(4):475-86.
57. Maulik D, Mundy D, Heitmann E, Maulik D. Evidence-based approach to umbilical artery Doppler fetal surveillance in high-risk pregnancies: an update. *Clinical obstetrics and gynecology*. 2010;53(4):869-78.
58. Saber H, Mahmoud S, Abd El- Monem A, Abd El Gaffar H. Role Of Middle Cerebral Artery / Umbilical Artery Pulsatility Index Ratio (cerebro-placental ratio CPR) For Prediction Of Fetal Outcome In Preeclamptic Patients. *Sohag Medical Journal*. 2019.
59. Mughal H, Mahmood Kamal M, Ayaz H, Awan MW, Usmani NN, Iqbal S, et al. Diagnostic Accuracy of Cerebroplacental Ratio in Prediction of Postnatal Outcomes in Oligohydramnios. *Cureus*. 2022.
60. Singh C, Wardha Junior R. Fetal Doppler versus NST as predictor of adverse perinatal outcome in severe PIH and IUGR. *Journal of Medical Science And clinical Research*. 2019.
61. Robindro K, Khatri M, Devi MR. FETAL DOPPLER VERSUS NST AS PREDICTOR OF ADVERSE PERINATAL OUTCOME IN SEVERE PIH AND IUGR. *Paripex Indian Journal Of Research*. 2020.
62. Anjum G, Mittal H, Chauhan N. Modified biophysical profile and perinatal outcome in high risk pregnancies. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*. 2021.