



AMNIOTIC FLUID INDEX VALUES AFTER PRETERM PREMATURE RUPTURE OF MEMBRANE AND ITS RELATION TO PERINATAL OUTCOME

Gynaecology

**Dr. Kumari
Anamika**

**Dr. Nandini
Goswami***

*Corresponding Author

**Dr. Namrata
Parida**

Dr. Debarshi Jana

ABSTRACT

PRETERM PREMATURE RUPTURE OF MEMBRANES (PPROM) IS A COMMON OBSTETRIC PROBLEM, ONE OF MOST COMMON CLINICAL EVENTS WHERE NORMAL PREGNANCY CAN TURN INTO HIGH RISK SITUATION FOR MOTHER AS WELL AS FETUS. THIS STUDY AIMS AT TO ASSESS THE MATERNAL MORBIDITY AND PERINATAL OUTCOMES IN PRE-TERM PRE MATURE RUPTURE OF MEMBRANES BETWEEN 32 TO 36 WEEKS OF GESTATION WITH RESPECT TO AMNIOTIC FLUID INDEX VALUE.

200 PREGNANT MOTHERS AT 32 TO 36 WEEKS OF GESTATIONAL AGE WITH PPROM WITHOUT ANY OTHER OBSTETRICAL COMPLICATIONS WERE INCLUDED IN THIS STUDY. USG FOR FPP & AFI WERE DONE ON ADMISSION OR, AS SOON AS POSSIBLE. THEN THE PATIENTS WERE MONITORED FOR ANY SIGN & SYMPTOMS OF MATERNAL & FETAL COMPROMISE. THE RELATION BETWEEN AFI VALUES & PERINATAL OUTCOME WAS OBSERVED.

AMONG 200 PATIENTS 80 HAD AFI VALUE ≤ 5 CM WHEREAS 120 PATIENTS HAD AFI > 5 CM AND GROUPED AS I & II RESPECTIVELY. 93.75% OF PATIENTS IN GROUP I (AFI ≤ 5) & 80.83% IN GROUP II WERE DELIVERED WITHIN TWO WEEKS OF PREMATURE RUPTURE OF MEMBRANE AND THE DIFFERENCE WERE STATISTICALLY SIGNIFICANT. 51.25% PATIENTS IN GROUP I & 27.5% IN GROUP II WERE DELIVERED BY CAESAREAN SECTION. CS WAS FOUND SIGNIFICANTLY HIGHER IN GROUP I (AFI ≤ 5). 40% BABIES IN GROUP I (AFI ≤ 5) & 26.6% IN GROUP II (AFI > 5) WERE FOUND TO HAVE THEIR 1 MIN APGAR SCORE < 7 . THIS ASSOCIATION WAS STATISTICALLY SIGNIFICANT. 48.75% BABIES IN GROUP I & 29.17% IN GROUP II WERE ADMITTED IN NICU AND THIS ASSOCIATION WAS STATISTICALLY SIGNIFICANT.

WE CONCLUDED THAT PERINATAL OUTCOME IS AFFECTED BY PPROM AND SPECIALLY RELATED WITH ITS DURATION, LONGER THE DURATION OF PPROM GREATER IS THE PERINATAL COMPLICATIONS.

KEYWORDS

INTRODUCTION -

Preterm premature rupture of membrane (PPROM) is defined as rupture of fetal membrane before onset of labor at less than 37 completed weeks of gestation. 1 PPROM most commonly present as a gush of fluid from the vagina, which is followed by persistent, uncontrolled leakage, however some patients may complain of only small or intermittent leakage or perineal wetness.

PPROM complicates approximately 2%-3% of all pregnancies below 37 weeks gestation. 2 PPROM complicates one-third of preterm births and is responsible for significant perinatal morbidity and mortality, largely related to prematurity. 3 There are numerous risk factors for PPROM, such as physiologic changes, intrauterine infection at early gestational age, lower socioeconomic status of pregnant women, inadequate prenatal care and inadequate nutrition during pregnancy, sexually transmitted infections, vaginal bleeding and smoking during pregnancy etc. 4 Subclinical intrauterine infection has been implicated as a major etiological factor in the pathogenesis and consequential maternal and neonatal morbidity in PPROM. 5 Preterm PROM complicates approximately 3 percent of pregnancies and leads to one third of preterm births. 4 PPROM is one of the important causes of preterm birth that can result in high perinatal morbidity and mortality along with maternal morbidity. 6

The fetal membranes and the amniotic fluid that they encase have functions that are critical for normal fetal protection, growth, and development. It typically is associated with brief latency between membrane rupture and delivery, increased potential for perinatal infection, and in utero umbilical cord compression. However, one of the most common complications in PPROM patients is intrauterine infection, which can lead to chorioamnionitis, metritis after delivery and perinatal outcome such as neonatal sepsis. 7,8 Other complications are cord compression leading to fetal distress, cord prolapse during rupture of membranes and placental abruption. 7,8 Perinatal outcomes

constitute prematurity, neonatal sepsis, respiratory distress syndrome (RDS), intraventricular hemorrhage (IVH), risk of fetal and neonatal death. 9 PROM is diagnosed by speculum vaginal examination of cervix and vaginal cavity, pooling of fluid in the vagina or leakage of fluid from cervix, ferning of dried fluid under microscopic examination and alkalinity of the fluid as determined by Nitrazine paper to confirm the diagnosis.

The main function of the amniotic fluid and amniotic membrane is protection to the fetus. Dynamic properties of the fluid render it to take up varied roles throughout the gestation.

During the prenatal period the functions are:

- Allowing the fetus freedom to move and enabling the skeletal to develop properly.
- Allowing the lung to develop properly.
- Maintain a relatively constant temperature around the fetus, thus protecting the fetus from heat loss.
- Protecting the fetus from outside injury by cushioning sudden blows or movements.
- Amniotic fluid is encased by amniotic membrane, which serves as an important barrier separating the sterile fetus and the amniotic fluid from a bacteria-laden vaginal canal.
- Amniotic membrane prevents prolapse of any intra-amniotic contents through the cervix, which often dilates somewhat prior to the onset of labour.
- Finally membranes also function as a repository for substrates for many critical biochemical processes, including storage of phosphoglycerolipids, which releases the precursors for prostaglandins. 9

Thus, any disruption in the integrity of the amniotic cavity might potentially interrupt or interfere with any or, all these important functions. During labour the amnion and chorion create a wedge that

helps in dilatation of the cervix, and prevents marked interference with the placental circulation during contraction.

Amniotic fluid index, first proposed by Phelan and Rutherford is the summation of the vertical diameter of the largest pocket in each of the four quadrants with the maternal umbilicus as a central reference point. Normal AFI values ranges from 5 to 25 cm.¹⁰ The transducer should be oriented in the longitudinal plane and there should be a minimum horizontal measurement of one centimeter for each pocket. In various studies it was found that AFI numeric values were significantly related to the following maternal-neonatal variables: high maternal body temperature, high maternal white blood cells (WBC) count and APGAR score >7 at 5 min. So, AFI value is a useful prognostic variable in management of third stage of labour associated with PPROM. Although many studies have been done to assess the same, this study aims at to assess the maternal morbidity and perinatal outcomes in pre-term premature rupture of membranes between 32 to 36 weeks of gestation with respect to amniotic fluid index value.

MATERIAL AND METHODS:

This prospective study was planned and carried out at a tertiary care hospital of Kolkata

Study Place: R. G. Kar Medical College and Hospital.

Study Population: Pregnant females attending RGKMCH Antenatal OPD & obstetrical emergency with complaints of premature rupture of membrane.

INCLUSION CRITERIA

1. Age group 18-35 yrs
2. Gestational age between 32 -36 weeks
3. Singleton pregnancy
4. presented with watery vaginal discharge in whom membrane rupture was confirmed

EXCLUSION CRITERIA

1. Vaginal bleeding
2. Known placenta praevia
3. Known congenital anomalies in the baby
4. Patients with clinical chorioamnionitis
5. Non-reassuring fetal status
6. Obstetrical indication for immediate delivery
7. Advanced labor (cervical dilatation >3)
8. Growth-restricted fetus at initial admission

Study Design: Hospital based Prospective cohort study.

Sample Size: All patients attending RGKMCH antenatal OPD, Department of gynecology & obstetrics emergency fulfilling the above mentioned inclusion and exclusion criteria.

Study Time: July 2016 to June 2017

INTERVENTION

Patients fulfilling the above mentioned criteria were selected and USG for FPP AFI were done at admission or as soon as possible. Then the patient was monitored for any sign or symptoms of maternal or fetal compromise.

PARAMETERS TO STUDY

a) MATERNAL

- Gestational age at admission
- Gestational age at delivery
- Mode of delivery
- Indications of caesarean section
- Incidence of chorioamnionitis, and other complications
- Incidence of abruption placenta

b) NEONATAL

- Birth weight
- APGAR SCORE at 1 min & 5mins after birth
- NICU admission
- Duration of stay at NICU
- Development of early neonatal sepsis
- Incidence of IVH
- Incidence of early neonatal death

METHODOLOGY

- Initially, the patients from the above mentioned criteria were

selected. After that, general examination, systemic examination and local examination with speculum examination, high vaginal microbial culture and sensitivity were carried out. Ultrasonography was done for each case to determine AFI values after premature rupture of membrane at the time of admission, and its relation with perinatal outcome was studied.

- We performed a prospective cohort study of infants delivered between 32 weeks – 36 weeks gestation after preterm premature rupture of the membranes. In all patients rupture of the membrane was diagnosed by sterile speculum examination using pooled fluid, fern test and Nitrazine paper test. Patients meeting the inclusion criteria were selected and examined by taking detailed history, physical examination, basic investigations, USG FPP-AFI. Eligible patients were subsequently categorized into 2 groups on the basis of the admission AFI measurement. Patients in group I were those with an AFI ≤ 5 cm, whereas those in group II had AFI > 5 cm. All patients received antibiotic prophylaxis at admission consisting of Ampicillin plus Erythromycin for 7 days following. In addition all patients received a single course of Betamethasone, consisting of total 24 mg Betamethasone injections during the first 24 hours after admission. Then the mother and fetus were monitored for any signs and symptoms of complications since admission till delivery of the baby. Fetal surveillance incorporated daily non-stress testing. For fetuses with non-reassuring, non stress test results, biophysical profile assessments were performed. Indications for delivery included: labor, the diagnosis of clinical chorioamnionitis or non-reassuring fetal test results.
- Then the neonate was followed up regarding NICU admission, development of early neonatal sepsis & END. The mother was followed up for any postnatal complication.

STATISTICAL ANALYSIS

For statistical analysis data were entered into a Microsoft excel spreadsheet and then analysed by SPSS 20.0.1. Data have been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. The median and the interquartile range have been stated for numerical variables that are not normally distributed. Student's independent sample's t-test was applied to compare normally distributed numerical variables between groups; Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate. p-value ≤ 0.05 was considered for statistically significant.

RESULT AND ANALYSIS:

In this study 200 women with PPROM were selected after applying inclusion & exclusion criteria. Among them 80 patients had their AFI ≤ 5 at admission and kept in group I (AFI ≤ 5) & rest 120 patients were kept in group II (AFI > 5). Various parameters including mode of delivery & perinatal outcomes were compared between these two. In our study, In group of AFI ≤ 5, 10% were aged ≤ 20 yrs, 70% were aged 21-29 yrs and 20% were aged 30-35 yrs. While in group of AFI > 5 20% were aged ≤ 20 yrs, 60% were aged 21-29 yrs and 20% were aged 30-35 yrs. Mean age in group of AFI ≤ 5 was 24.49 yrs ± 3.98 and in second group (AFI > 5) was 24.13 yrs ± 4.20. On analysis, no statistical significance was seen in either group (P value = 0.153). In our study 57.5% (46) patients were primigravida in group AFI ≤ 5, while 60.8% (73) in group AFI > 5, and 42.5% (34) patients were multigravida in group AFI ≤ 5 & 39.2% (47) patients in the group AFI > 5. No statistical significance was seen in either group (P value = 0.638). In our study in group I (AFI ≤ 5), 60% (48) patients were at 32-34 weeks of gestation, while 40% (32) were at 34.1 to 36 weeks and in other group (AFI > 5), 58.33% (70) patients were at 32-34 weeks of gestation and 41.67% (50) were at 34.1 - 36 weeks. Thus, distribution of gestational age among the two groups was not statistically significant. In our study, in group I (AFI ≤ 5) latency was < 2 weeks in majority (93.75%, 75) patients and ≥ 2 weeks only in 6.25% (5) patients. Whereas in group II (AFI > 5), latency was < 2 weeks in 80.83% patients and ≥ 2 weeks in 19.17% patients. Thus, there was association between AFI and latency in two groups and it was found statistically significant (p value = 0.010). Our data indicated that patients with oligohydramnios were more likely to undergo emergency cesarean delivery which is consistent with the findings of previous studies. According to our study 51.25% (41) patients were delivered by caesarean section and 48.75% (39) were delivered vaginally in group AFI ≤ 5 while in group AFI > 5, 27.5% (33) patients were delivered by caesarean section and 72.5% (87) were delivered vaginally & statistically significant difference was found in

mode of delivery among the two groups (P value - 0.0007). Our study showed that in group I (AFI $\leq$ 5), 40%(32) babies had their 1 min APGAR score <7 , while 1 min APGAR score was ≥ 7 in 60% (48) babies. And in group II (AFI >5), 26.6%(32) babies had their 1 min APGAR score <7 , while ≥ 7 in 73.3%(88) babies. On statistical analysis significant difference was found (P value -0.048). According to our study 13.75% (11) babies had their 5 min APGAR score <7 , & 86.25% (69) babies had their 5 min APGAR score ≥ 7 in group AFI $\leq$ 5. Whereas in group AFI >5 , 10% (12) babies had their 5 min APGAR score <7 , while 5 min APGAR score ≥ 7 in 90 % (108) babies. Difference of APGAR score at 5 minutes among two groups was not statistically significant (P value -0.048). This might be due to better immediate neonatal resuscitation. There was no statistically significant difference of birth weight between the 2 groups. In group with AFI $\leq$ 5, 75%(60) babies had their birth weight <2.5 Kg while 25%(20) babies had ≥ 2.5 Kg. and, in second group (AFI >5), 73.33%(88) babies had their birth weight <2.5 Kg while 26.67%(32) babies had ≥ 2.5 Kg; P value -0.7929). Our study showed that development of sepsis in the neonate was not related to oligohydramnios (P value -0.420). In our study 17.5%(14) babies in the group I (AFI $\leq$ 5) & 11.7%(14) babies in second group (AFI >5) had developed respiratory distress syndrome. statistically significant difference of RDS among two groups was not found (P value -0.2453).

In our study 46.25% (37) babies in group AFI $\leq$ 5 & 30% (36) in second group with AFI >5 were admitted in NICU. On analysis relation between AFI values and NICU admission was found statistically significant (P value - 0.0197). In our study mean NICU stay was almost similar in both groups, there was no statistical difference (P value - 0.3915). In our study there was no statistical difference in neonatal death was found between two groups (P value - 0.8214). In our study the relation between AFI and incidence of chorioamnionitis was not found statistically significant (P value - 0.5089). This is probably because of liberal use of prophylactic antibiotics. In our study incidence of maternal complications like abruption, PPH, & puerperal sepsis was similar in both the groups showing no statistically significant difference.

DISCUSSION

Preterm PROM is an important cause of perinatal morbidity and mortality, particularly because it is associated with brief latency from membrane rupture to deliver, perinatal infection, and umbilical cord compression due to oligohydramnios. Complications of preterm premature rupture of membranes count for approximately 25% to 33% of all preterm deliveries. Expectant management with antenatal antibiotics and corticosteroid administration are recommended the standard of care in the setting of PPRM at gestational ages of ≤ 34 ⁸⁻¹⁰. Current evidence suggests adjunctive antibiotic therapy to reduced gestational age-dependent and infectious infant morbidity. Amniocentesis and amniotic fluid volume have been advocated as a useful adjunct for identifying these patients. Several studies have implicated oligohydramnios in patients with preterm premature rupture of the membranes as a significant risk factor for perinatal infection, and fetal distress, cesarean delivery, and neonatal death^{10,11}. Therefore, we aimed to provide information to advance a forecast about perinatal outcomes in PPRM.

In this study 200 women with PPRM were selected after applying inclusion & exclusion criteria. Among them 80 patients had their AFI $\leq$ 5 at admission and kept in group I (AFI $\leq$ 5) & rest 120 patients were kept in group II (AFI >5). Various parameters including mode of delivery & perinatal outcomes were compared between these two. In our study, in group I (AFI $\leq$ 5) latency was <2 weeks in majority (93.75%, 75) patients and ≥ 2 weeks only in 6.25% (5) patients. Whereas in group II (AFI >5), latency was <2 weeks in 80.83% patients and ≥ 2 weeks in 19.17% patients. Thus, there was association between AFI and latency in two groups and it was found statistically significant (p value - 0.010). Similar result was found in the study by Atalay Ekin et al¹² in which the patients with AFI <5 cm exhibited significantly a shorter latency to delivery (p <0.001). But in study by Borna S, et al¹¹ latency period was found similar in both the groups. (Statistically not significant).

Our data indicated that patients with oligohydramnios were more likely to undergo emergency cesarean delivery which is consistent with the findings of previous studies. According to our study 51.25% (41) patients were delivered by caesarean section and 48.75% (39)

were delivered vaginally in group AFI $\leq$ 5 while in group AFI >5 , 27.5%(33) patients were delivered by caesarean section and 72.5%(87) were delivered vaginally & statistically significant difference was found in mode of delivery among the two groups. (P value - 0.0007). Similar observation seen in the study by Atalay Ekin et al¹², where a significantly higher rate of emergency cesarean delivery (p = 0.043) was found in group with AFI $\leq$ 5. Similar result was seen in the study of Fatemeh Tavassoli et al¹³, a higher rate of cesarean section due to fetal distress (p = 0.008) was demonstrated in the patients with AFI <5 . Another study by Sedigheh Borna et al¹⁰ showed that Patients with AFI <5 cm had greater frequency of C/S delivery for non reassuring fetal tests (23% vs 2.8%) (p = 0.001).

Our study showed that in group I (AFI $\leq$ 5), 40%(32) babies had their 1 min APGAR score <7 , while 1 min APGAR score was ≥ 7 in 60% (48) babies. And in group II (AFI >5), 26.6%(32) babies had their 1 min APGAR score <7 , while ≥ 7 in 73.3%(88) babies. On statistical analysis significant difference was found (P value -0.048) and it was supported by the study of Alex Borna S et al¹¹. They also found the similar result. "A higher frequency of perinatal mortality & APGAR scores less than seven at 1 minute, when the AFI was lower than 5 cm". Another study by Atalay Ekin et al¹² patients with an AFI <5 cm demonstrated a significantly lower neonatal APGAR score at first minute (p = 0.004).

According to our study 13.75% (11) babies had their 5 min APGAR score <7 , & 86.25% (69) babies had their 5 min APGAR score ≥ 7 in group AFI $\leq$ 5. Whereas in group AFI >5 , 10% (12) babies had their 5 min APGAR score <7 , while 5 min APGAR score ≥ 7 in 90% (108) babies.

Difference of APGAR score at 5 minutes among two groups was not statistically significant. (P value -0.048) This might be due to better immediate neonatal resuscitation.

In study by Fatemeh Tavassoli et al¹³, the first minute Apgar score ≤ 7 was significantly higher in group II (AFI <5) compared to group I (p = 0.005), but although the five minute APGAR score ≤ 7 was higher in group II (AFI <5), there was no significant difference between the two groups (p = 0.055).

In a study by Borna S et al¹¹ when comparing the newborns in two groups with AFI <5.0 cm and AFI >5.0 cm, a statistically significant difference was not observed in relation to APGAR scores lower than seven at 1 and 5 minutes, need for admission to NICU, presence of any perinatal complications, sepsis and early or late neonatal mortality.

In our study 46.25% (37) babies in group AFI $\leq$ 5 & 30% (36) in second group with AFI >5 were admitted in NICU. On analysis relation between AFI values and NICU admission was found statistically significant (P value - 0.0197). This finding was similar to the study performed by Borna S et al¹¹.

In our study mean NICU stay was almost similar in both groups, there was no statistical difference (P value - 0.3915). In contrast to it, in the study by Ladella et al¹⁴ AFI greater than 5 cm in PPRM was found associated with decreased length of stay in the NICU (P <0.130). In our study there was no statistical difference in neonatal death was found between two groups (P value - 0.8214) which in contrast to the result of study done by Borna S et al¹¹ where neonatal death was significantly more frequent when AFI was less than 5.0 cm (32.7 vs. 10.8%; RR 3.02; 95CI 1.10-8.3; p = 0.02).

In our study the relation between AFI and incidence of chorioamnionitis was not found statistically significant (P value - 0.5089). This is probably because of liberal use of prophylactic antibiotics. This finding was in accordance with the study of Piazza et al¹⁵. Study by Sedigheh Borna et al¹⁰ demonstrated that patients with AFI ≤ 5 cm had a significant increase in the frequency of clinical chorioamnionitis (P <0.001).

In our study incidence of maternal complications like abruption, PPH, & puerperal sepsis was similar in both the groups showing no statistically significant difference. Similar results were observed in another study by Fatemeh Tavassoli et al¹³ in terms of placental abruption, spontaneous start of contractions and pregnancy termination due to different causes. Study by Sedigheh Borna et al¹⁰

demonstrated no significant difference in occurrence of Post-partum infections in 2 groups.

CONCLUSION

In this study 200 pregnant mothers with PPROM at 32 – 36 weeks of pregnancy were studied to see the relation between perinatal outcome & their AFI values at admission. Patients with $AFI \leq 5$ exhibited significantly shorter latency to delivery, and higher rate of Caesarean section than those with $AFI > 5$. 1 min APGAR score < 7 was found more frequently when AFI was ≤ 5 and NICU admission was also found statistically more frequently in group with $AFI \leq 5$.

So, this study helps to conclude that perinatal outcome is affected by PPROM and specially related with its duration, longer the duration of PPROM greater is the perinatal complications.

REFERENCES

- Uma S, Nisha S, Shikha S. A prospective analysis of etiology and outcome of preterm labor. *Journal of Obstetrics and Gynecology of India*. 2007 Jan 1;57(1):48-52.
- Akter S, Akter R, Rashid M. Preterm Prelabour Rupture of the Membrane & Feto-Maternal outcome: an Observational Study. *Journal of Bangladesh College of Physicians & Surgeons*. 2010;28(1):17.
- Mohan SS, Thippaveeranna C, Singh NN, Singh LR. Analysis of risk factors, maternal and fetal outcome of spontaneous preterm premature rupture of membranes: a cross sectional study. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*. 2017 Aug 28;6(9):3781-7.
- Medina TM, Hill DA. Preterm premature rupture of membranes: diagnosis and management. *Am Fam Physician*. 2006 Feb 15;73(4):659-4.
- Simhan HN, Canavan TP. Preterm premature rupture of membranes: diagnosis, evaluation and management strategies. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2005 Mar 1;112:32-7.
- Noor S, Nazar AF, Bashir R, Sultana R. Prevalance of PPROM and its outcome. *J Ayub Med Coll Abbottabad*. 2007 Oct;19(4):14-7.
- Tavassoli F, Ghasemi M, Mohamadzade A, Sharifian J. Survey of pregnancy outcome in preterm premature rupture of membranes with amniotic fluid index < 5 and ≥ 5 . *Oman medical journal*. 2010 Apr;25(2):118.
- Yoon BH, Kim YA, Romero R, Kim JC, Park KH, Kim MH, Park JS. Association of oligohydramnios in women with preterm premature rupture of membranes with an inflammatory response in fetal, amniotic, and maternal compartments. *American journal of obstetrics and gynecology*. 1999 Oct 1;181(4):784-8.
- Weissmann-Brenner A, O'Reilly-Green C, Ferber A, Divon MY. Values of amniotic fluid index in cases of preterm premature rupture of membranes. *Journal of perinatal medicine*. 2009 May 1;37(3):232-5.
- Vintzileos AM, Campbell WA, Nochimson DJ, Weinbaum PJ. Degree of oligohydramnios and pregnancy outcome in patients with premature rupture of the membranes. *Obstetrics and gynecology*. 1985 Aug;66(2):162-7.
- Borna S, Borna H, Hantoushzadeh S. Perinatal outcome in preterm premature rupture of membranes with Amniotic fluid index < 5 ($AFI < 5$). *BMC pregnancy and childbirth*. 2004 Dec;4(1):15.
- Ekin A, Gezer C, Taner CE, Ozeren M. Perinatal outcomes in pregnancies with oligohydramnios after preterm premature rupture of membranes. *The Journal of Maternal-Fetal & Neonatal Medicine*. 2015 Nov 2;28(16):1918-22.
- Tavassoli F, Ghasemi M, Mohamadzade A, Sharifian J. Survey of pregnancy outcome in preterm premature rupture of membranes with amniotic fluid index < 5 and ≥ 5 . *Oman medical journal*. 2010 Apr;25(2):118.
- Ladella S, Leung T, Cortez C. Effects of Amniotic Fluid Index on Perinatal Outcomes in Preterm Premature Rupture of Membranes [37o]. *Obstetrics & Gynecology*. 2017 May 1;129:S162.
- Piazza J, Anceschi MM, Cerekja A, Brunelli R, Meloni P, Marzano S, Cosmi E. Validity of amniotic fluid index in preterm rupture of membranes. *Journal of perinatal medicine*. 2007 Oct 1;35(5):394-8.