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AFOD (Amniotic Fluid Optical Density)-A Predictor of Fetal Maturity and Outcome.

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Abstract:
Objective: *To estimate Amniotic fluid Optical density (AFOD) and establish correlation between (AFOD) and gestational age, birth weight and functional maturity of the newborn.*
Materials &Methods: *A descriptive study was conducted on 100 pregnant women who attended Government General Hospital, Guntur, during a period of 1 year from April 2016 to march 2017 by taking amniotic fluid samples under aseptic precautions at 3-4cm cervical dilatation and after incision on the uterus from the bulging membranes- in women delivering through vaginal and caesarean routes respectively.*
Results: *None of the babies developed RDS when AFOD was more than 0.40. On the other hand, babies born with AFOD value < 0.40 (n=18) were functionally premature and developed varying degrees of RDS and had birth weights ranging from 2300 to 3000 gms.*
Conclusion: *AFOD correlates well with the functional maturity of the newborn.*

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I. Introduction

In spite of great scientific advancement, the mechanism behind the gestational age at which the spontaneous onset of labor is taking place with each pregnancy, and the gestational age at which completion of functional maturity is attained with each fetus has eluded the obstetrician. Different fetuses attain completion of functional maturity at different gestational ages with different birth weights, at any time between 36 weeks to 42+ weeks. One of the most important preventive measures in obstetrics is the individual evaluation of the most appropriate time to terminate a pregnancy**.**It is a conventional decree that babies born between 37-40 weeks of gestation are completely mature. We anticipate the problems of prematurity in those born before 37 weeks which include respiratory distress syndrome, retinopathy of prematurity, Intraventricular hemorrhage, peri ventricular leukomalacia, brain disorders such as neonatal encephalopathy, cerebral palsy, necrotizing enterocolitis, fetal -to-maternal hemorrhage, hyperbilirubinemia, fetal cardiac arrhythmias and that there would be complications of post maturity in those born after 42 weeks. However, it has been observed that at least 3% of preterm births occur beyond 37 gestational calendar weeks. Even after 40 weeks "full term" an incidence of 0.25% RDS has been recorded. Maturity is neither mass nor time and cannot be assessed in grams or units of time. Therefore modern neonatologists and obstetricians successfully worked out maturity quantizing in points without taking into account mass, length or gestational age of fetuses and newborns.Amniotic fluid turbidity, the objective measure of which is Amniotic Fluid Optical Density (AFOD) correlates with the lung maturity as well as complete maturity of the fetus when various studies have been inferred. In this study we set out to find the AFOD , at birth (at spontaneous onset of labor/ LSCS) and its correlation with the variables used to define "term" namely, gestational age, birth-weight of the newborn and the neonate's functional maturity.

II. Objectives

1. To establish correlation between Amniotic fluid Optical density (AFOD), gestational age, birth weight and functional maturity of the newborn.
2. To obtain mean AFOD at **spontaneous** onset of labor.
3. To study the functional maturity of the newborns, especially in terms of lung maturity by means of presence or absence of RDS in babies born out of spontaneous labor and in those born by elective termination.

III. Materials And Methods

A descriptive study was conducted on one hundred pregnant women who attended Government general Hospital, Guntur, during a period of 1 years from April 2015 to October 2016, with the following **inclusion criteria**:

● Women who underwent first trimester scan and crown rump length estimation, or
● Women with regular periods who underwent scan at less than 20 weeks gestation which is in agreement with the gestational age calculated from the last menstrual period

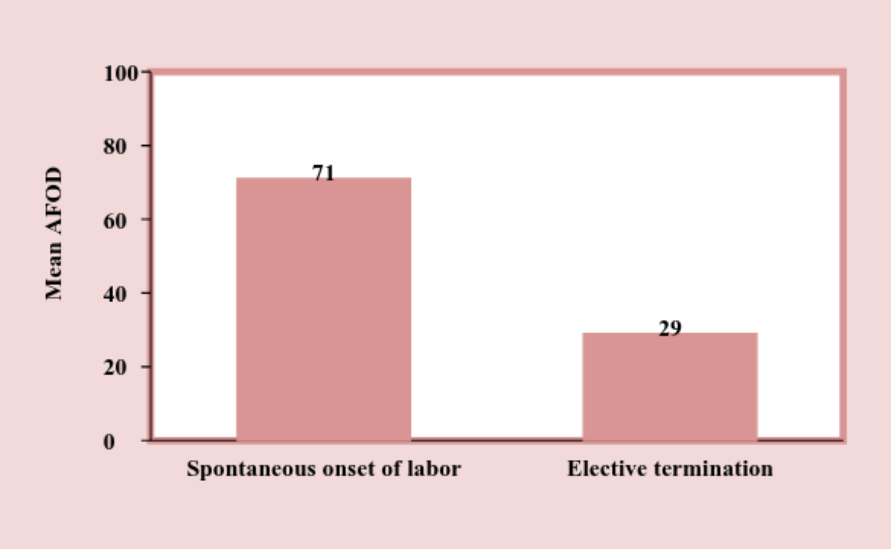
Exclusion criteria:
● Blood stained and meconium stained amniotic fluid samples
● Intrauterine growth restriction
● Premature rupture of membranes
● Preterm premature rupture of membranes
● Amniotic fluid index <5 and >25

Informed consent was taken from all women prior to artificial rupture of membranes and before LSCS
Under aseptic precautions amniotic fluid samples were collected while doing amniotomy after 3-4cm dilatation by an intramuscular needle fitted with a 2ml disposable syringe. This procedure is done under vision gentlty by inserting one Sim's speculum, if necessary two, taking care to avoid injury to the presenting part.
Amniotic fluid samples are collected at ceasarean section after careful incision on the uterus from the bulging membranes.
The color and turbidity of fresh uncentrifuged amniotic fluid samples thus obtained was measured subjectively by naked eye inspection and quantified subjectively as follows:

Color/ Turbidity of amniotic fluid	**Score**
Watery	1
Milky	2
Buttermilk like	3
Curd like	4

The colour and turbidity of the fresh uncentrifuged sample was objectively quantified by colorimetry. The measurement of AFOD was done at 650 nm after the reading of control test tube with tap water. Babies are observed for the amount of Vernix on their skin immediately after birth before drying of the baby. Routine protocol for neonatal resuscitation was followed. Birth weights were recorded for all babies. APGAR scores at 1minute and 5 minutes were obtained. Babies were observed for classical signs of respiratory distress (tachypnea >60breaths /min, grunting, retraction of ribs, sternum). Suspected cases of distress were resuscitated with bag-mask ventilation with oxygen and referred to NICU for further management. Respiratory distress was graded using Downe's score.

IV. Results And Analysis



Graph .1- Distribution of cases spontaneous onset of labour and elective termination
The mean AFOD was found to be 1.10 in the primi gravidae and 1.03 in the multi in the non RDS group, while it was 0.29 in the primi, 0.30 in multi in RDS group. The mean AFOD at spontaneous onset of labour was 1.08

Table.1 -Characteristics of AFOD and birth weight in RDS and non RDS compared to total population

	Without RDS	With RDS	Total
No. of cases	92	8	100
Mean period of Gestation	273.52±9.40	255.5±13.7	272.08±10.8
AFOD mean±SD	1.0580±0.34	0.2937±0.03	0.9969±0.39
Mean birth weight±SD	3.1478±0.38	2.3875±0.35	3.087±0.43
AFOD<0.40	0	8	8
Birth weight/gestational age±SD	11.5±1.23	9.31±0.95	11.32±1.34

Table. 2-Summary of characteristics of AFOD and birth weight in different gestational ages

Gestational age in Days	<246	246-252	253-259	260-266	267-273	274-280	>280	Total
No.of cases	1(1%)	7(7%)	7(7%)	11(11%)	26(26%)	21(21%)	27(27%)	100(100%)
Birth weight mean	2.1±0	2.357±0.22	2.571±0.39	3.054±3.12	3.125±0.29	3.204±0.31	3.331±0.37	3.087±0.43
Cases without RDS	0	4	5	11	26	19	27	92
Cases with RDS	1	3	2	0	0	2	O	8
Mean AFOD at without RDS	-	0.67±0.03	0.88±0.17	0.83±0.11	1.04±0.21	0.91±0.20	1.35±0.43	1.05±0.34
Mean AFOD at withRDS	0.26±0	0.30±0.02	0.26±0.02	-	-	0.33±0.01	-	0.29±0.03
BW/GA	8.823±0.0	9.425±0.85	10.03±1.44	11.55±0.97	11.51±1.08	11.61±1.14	11.72±1.31	11.32±1.34

V. Discussion

In the current study between any two groups among 3 to 7 there is no radical change in mean AFOD values when cases of RDS were excluded for analysis and remained same after adjusting for birth weights. All the babies born with AFOD value around the mean 1.038±0.103 SD were fully functionally mature. Their skin was mature, pink with very little vernix caseosa adherent to the surface. None of the babies developed RDS when AFOD was more than 0.40. On the other hand, babies born with AFOD value < 0.40 (n=18) were functionally premature and developed varying degrees of RDS and had birth weights ranging from 2300 to 3000 gms. Their skin was premature, thin, shiny and red in color with plenty of vernix caseosa adherent to the surface. The largest AFOD value at which babies developed RDS was 0.40. Babies born with much higher AFOD values (>1.75)had post-mature skin changes(fig4.3,4.4,4.5).Initially the studies of optical density were done with centrifuged samples. The cut off was determined to be 0.15. The values are variable depending on centrifugation speed and time. The mean AFOD at spontaneous onset of labor(1.08) was more than the mean(0.80) for those with elective termination indicating **complete maturity at onset of labor** rather than gestational age or birth weight.The uncentrifuged samples with OD around 0.40 on centrifugation at 2000 rmp for 10 mins gives the OD reading around 0.15. We observed that Babies born with AFOD value < 0.40, at a lower gestational age developed moderate to severe and prolonged RDS as compared to babies born with AFOD value < 0.40 at a later gestational age who developed milder RDS for shorter duration. The findings are in accordance with the previous studies.

A 38 week baby weighing 3.2 kg with sternal retractions with respiratory distress. The skin was premature, thin, red with plenty of vernix adherent. AFOD was 1.34.

A 38 week baby weighing 3 kg without RDS. Skin was mature, pink with no adherent vernix. AFOD was 0.11

Skin Changes In Functionally Premature, Mature And Post Mature Babies:

The skin maturation follows lung maturity resulting in complete functional maturity of fetus. Considering skin maturity as reliable endpoint, prematurity, optimum maturity and post maturity are part of a spectrum which can happen at any time within 36 to42 weeks GA during which birth is taking place. Sometimes a failure or delay of mechanism of initiation of labor can result in post maturity as revealed by post mature skin changes seen at high AFOD values > 1.75 which was noted in 4.3% of study population. At a particular day of pregnancy at chronological "term" there could be fetuses who are in the process of obtaining complete functional maturity. Conversely a fetus which is functionally mature at 36 weeks, becomes post mature if the delivery is delayed. The understanding of AFOD prevents iatrogenic prematurity as well as complications of post maturity thereby optimizing labor. The significance of AFOD is not only to know about lung maturity, but, much of importance lies in defining events taking place beyond lung maturation which include skin maturity and onset of labor. Studies have shown that induced (non-spontaneous) labors have higher Oxytocin requirements and increased incidence of PPH. Presuming the inductions as inappropriate in time, the iatrogenic complications and suffering could have been probably avoided if the inductions were AFOD guided. Inductions just based only on chronological age of the fetus might be the reason for requirement of heavy doses of prostaglandins, dysfunctional labor prolonged induction delivery intervals, more number of instrumental deliveries, pain and larger doses of narcotic analgesia, neonatal respiratory depression, perineal tears and increased caesarean section rates. Such maternal and neonatal morbidities are the result of mechanization of natural process of labor. Induction of labor needs to be reviewed in light of AFOD values or its equivalent indicators which determine the preparedness of labor and hence the biological gestational age that is more relevant than "EDC"(Estimated Date of confinement) which itself is a misnomer.

We infer that complete functional maturity and onset of labor takes place at individual term with mean AFOD **around 1** irrespective of birth weight and gestational age in our study population, which is the point of complete maturation.

VI. Comparison Of Studies

The Following Studies Show Similar Results To This Study:

In an old study by Joze H. Zabkar in 1865 it has been observed that the delivery of a mature newborn in most cases starts spontaneously at the moment we recognize milky amniotic fluid by amnioscopy.[1] Klimeketal in many of his studies convincingly proves that each feto-maternal unit matures at its own time and that this time is irrespective of any single parameter considered as of now.[3] In an article by S.H.Ramet al published in Calicut Medical journal2009; 7(4):e2 it is inferred that complete functional maturity and onset of labor takes place at individual term with mean AFOD around 0.98 irrespective of birth weight and gestational age, which is taken as the basis for this work.

VII. Summary

● It is observed that few babies born even at 35+ wks are fully mature and do not develop RDS.on the other hand few born even after 40 wks are functionally premature and develop RDS.
● AFOD correlates well with the functional maturity of the newborn while others not.
● AFOD can be used to measure the quantum of functional maturity of fetus
● At AFOD value of 1 babies are fully functionally mature
● Babies with AFOD¸ less than 0.4 are immature and all of them develop RDS irrespective of gestational age, AFOD around 1 are completely mature. Those with AFOD more than 1.75 showed postmature changes
● Every fetus has its own maturity potential attaining functional maturity occurs at different gestational ages with different birth weights

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