The effectiveness of utilizing the Zhang's criteria compared to Friedman's criteria in increasing the rate of successful vaginal delivery among primigravid parturient in a tertiary hospital*

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ABSTRACT

Objective: To determine the effectiveness of utilizing the Zhang's criteria as compared to Friedman's criteria in increasing the rate of successful vaginal delivery among primigravid parturient in a tertiary government hospital.

Material and Methods: This is a prospective cohort study conducted in a tertiary hospital. The population consisting of primigravid parturient of any age admitted at term pregnancy with a gestational age between 37 and 42 weeks. Included were singleton pregnancy, with no co-morbidities, vertex position on admission, with intact amniotic membranes, and in active phase of labor (either 4cm or 6cm cervical dilatation), who consulted at the emergency room of the institution. Multigravid patients, those with multiple pregnancy and ruptured membranes were excluded from the study. Two groups of cohorts were recruited based on the internal examination of the principal investigator upon admission. Cohort A is composed of pregnant women admitted at 6cm cervical dilatation fulfilling the Zhang's criteria whereas Cohort B is composed of pregnant women admitted at 4cm cervical dilatation fulfilling the Friedman's criteria. Socio-demographic characteristics were recorded. Their course of labor was monitored; contractions were augmented accordingly if needed. The mode of delivery was noted such as spontaneous vaginal delivery or cesarean section. The neonatal outcome was recorded as to apgar scores obtained for both groups.

Results: A greater proportion of parturients were young, single and with normal body mass index. A higher proportion of those under Friedman's group was augmented with oxytocin (100% vs. 53.4%). A greater proportion of those in Zhang's group had successful vaginal delivery (98.2% vs. 81.8%) (p=0.011, OR=18.167, 95% CI: 1.943, 169.867). Parturients under Zhang's group had achieved less hours of active labor.

Conclusion: The rate of successful vaginal delivery is significantly different between the two groups. A greater proportion of pregnant women under Zhang's group achieved successful vaginal delivery as compared to Friedman's group.

Keywords: Friedman curve, Labor, Parturient, Primigravid

INTRODUCTION

The greatest impediment to understanding normal labor is recognizing its start. The strict definition of labor – uterine contractions that bring about demonstrable effacement and dilatation of the cervix – does not easily aid the clinician in determining when labor has actually begun. Several methods maybe used to define its start. One defines onset as the time when painful contractions become regular. Unfortunately, uterine activity that causes discomfort, but that does not represent true labor, may develop anytime during pregnancy. False labor often stops spontaneously, or it may proceed rapidly into effective contractions.[1]

A second method defines the onset of labor as beginning at the time of admission in the labor unit. In the United States, admission for labor is frequently based on the extent of cervical dilatation accompanied by painful contractions. If a woman has intact membranes, then cervical dilatation of 3 to 4cm or greater is presumed to be a reasonably reliable threshold for the diagnosis of labor.[1]

Dr. Emanuel A. Friedman introduced the Friedman Curve in 1955. He described a characteristic sigmoid pattern for labor by graphing cervical dilatation against time. This is known to be the gold standard for rates of cervical dilatation and fetal descent during active labor.[2] The Friedman curve for normal active labor is one of the first pieces of knowledge that most obstetricians acquire. According to Friedman, the active phase of labor begins when the cervical dilatation is at 4cm and as this commences, so is the indication for admission of the patient.[1] With the curve as a basis for normal labor, the diagnosis of abnormal labor patterns was derived (Table 1). As stated by Cunningham et.al., cesarean section was the ultimate end point in the management of these cases (Table 1).

In this case, labor onset commences at the time of admission. This presumptive method obviates many of the uncertainties in diagnosing labor during earlier stages of cervical dilatation. There is a retrospective, observational study conducted by Zhang et al. wherein contemporary population observed several important differences from the classic Friedman curve. First, after having plotted a large number of labor curves, it became clear that there are a substantial number of parturients who may not have a consistent pattern of the active phase of labor, particularly in nulliparous women. Labor may progress more gradually but still achieve vaginal delivery. Second, even in women who had an active phase characterized by precipitous cervical dilation in the late first stage, the active phase often did not start until 6 cm or more, and the rate of cervical dilatation accelerated after 6cm.[3] This seems to differ materially from prevailing concepts by Dr. Friedman that the active phase starts before 4 cm and that 4 cm is a commonly used milestone.

In one study, they defined the active phase in induced labor as cervical dilation at 4 cm with 90% or more effacement or 5 cm dilation regardless of effacement from a 288 primigravids.[4] However, another study has found that among women who had no active phase arrest, 50% of them entered active phase by 4 cm dilatation, 74% entered active phase by 5 cm, and 89% entered active phase by 6 cm. These findings point to the importance of separating an average starting point of active phase from a clinical diagnosis of labor arrest. Judging whether a woman is having labor protraction and arrest should not be based on a research definition of an average starting point or average duration of labor. Instead, an upper limit of what is considered "normal labor" should be used in patient management. As long as the labor is within a normal range and other maternal and fetal conditions are reassuring, a woman should be allowed to continue the labor process.[5]

Even though cesarean section was deemed to be a turning point in the field of obstetrics, its disadvantages as to the complications associated with the procedure is admittedly more severe compared to a vaginal delivery. Because of this, several measures were taken wherein new recommendations were given as per the

Table 1. Abnormal Labor Patterns, Diagnostic Criteria, and Methods of Treatment (Williams, Obstetrics and Gynecology 24th ed.)

Labor Pattern	Diagnostic Criteria		Preferred Treatment	Exceptional Treatment
	Nulliparous	*Multiparas*		
Prolongation Disorder (Prolonged latent phase)	> 20 hr	> 14 hr	Bed rest	Oxytocin or cesarean delivery for urgent problems
Protraction Disorders				
1. Protracted active-phase dilatation	< 1.2 cm/hr	< 1.5 cm/hr	Expectant and support	Cesarean delivery for CPD
2. Protracted descent	< 1.0 cm/hr	< 2 cm/hr		
Arrest Disorders				
1. Prolonged deceleration phase	> 3 hr	> 1 hr	Oxytocin without CPD	Rest if exhausted
2. Secondary arrest of dilatation				
3. Arrest of descent	> 2 hr	> 2 hr	Cesarean delivery with CPD	Cesarean delivery
4. Failure of descent	> 1 hr, with no descent in deceleration phase or second stage	> 1 hr		

article made by The American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine in 2014 with recommendations for safe prevention of primary cesarean section (Table 3). Recommendations from the article touched on first and second stages of labor, fetal heart rate monitoring, induction of labor, suspected fetal macrosomia, excessive maternal weight gain, and twin gestations. In relation to the first stage of labor, the following statement is a specific recommendation that suggested lenience in comparison to Friedman's criteria. Cervical dilation of 6 cm should be considered as the threshold for the active phase of most women in labor. Thus, before 6 cm of dilation is achieved, standards of active phase progress should not be applied.[6]

There is also a study conducted in Japan where they compared the labor progression of Japanese nulliparous women using Friedman's and Zhang's. The new developed Japanese Suzuki-Horiuchi labor curve was similar to Zhang's curve, the Suzuki-Horiuchi curve was smooth and more gradually sloped than Friedman's curve.[7]

Since the birth of the Friedman curve, no revisions were made and were applied globally for over 60 years in the field of obstetrics.[2] The criteria created 60years ago may no longer be applicable to contemporary populations and for current obstetric management. Increasing maternal age, maternal size as well as differing socio-economic status has made labor a more challenging process. Moreover, frequent obstetric intervention may have altered the natural labor process.[3]

In this regard, the purpose of the study will redound to the benefit of all obstetricians in utilizing Zhang's criteria on admission of primigravids to increase proportion of successful vaginal deliveries.

OBJECTIVES

A. General Objective

To determine the effectiveness of utilizing the Zhang's criteria as compared to Friedman's criteria in increasing the rate of successful vaginal delivery among primigravid parturient in a tertiary government hospital.

B. Specific Objectives

1. To compare the socio-demographic characteristics of pregnant primigravid parturients who underwent successful vaginal delivery using the Zhang's criteria versus Friedman's criteria

2. To determine the proportion of primigravid who underwent successful vaginal delivery using the Zhang's criteria versus Friedman's criteria

3. To determine the mean duration of active labor of each parturient who underwent vaginal delivery using the Zhang's criteria versus Friedman's criteria

MATERIALS AND METHODS

Setting

The study was conducted in a tertiary hospital

Study Period

December 2018 to May 2019

Population

The population consisting of primigravid parturient of any age admitted at term pregnancy from gestational age between 37 and 42 weeks.

Inclusion/Exclusion Criteria

Included were: singleton pregnancy, with no co-morbidities, vertex position on admission, with intact amniotic membranes, and in active phase of labor (either 4cm or 6cm dilatation), consulted at the emergency room of the institution. Multigravid patients, those with multiple pregnancy and ruptured membranes were excluded from the study.

The principal investigator \had the informed consent form signed, did the admission assessment, noted the socio-demographic characteristics, and provided the labor and delivery services under the supervision of attending consultant physicians. At the emergency room, the patient was assigned into two groups of cohorts upon admission. These two groups of cohorts were admitted based on the eligibility criteria prescribed by the principal investigator. Once admitted, parturient were categorized as to their cervical dilatation. The first group of cohort consist of parturient with baseline cervical dilatation of 6cm under Zhang's group. The second group of cohort consists of parturient with cervical dilatation of 4cm under Friedman's group (Figure 1).

Their labor was monitored, contractions were corrected accordingly, noted whether the labor was augmented with oxytocin or not. Mode of delivery (either normal spontaneous delivery or cesarean section) and the fetal outcome as to apgar scores obtained for two groups were recorded. The partograph observed during labor were monitored and the decision to do cesarean section was made based on the criteria indicated in Williams Obstetrics Textbook (Figure 1).

The primary outcome of the study includes: Proportion of pregnant women who underwent successful vaginal delivery. Secondary outcomes include the following: (1) Proportion of pregnant women who underwent cesarean section (2) Average hours of active labor for both groups
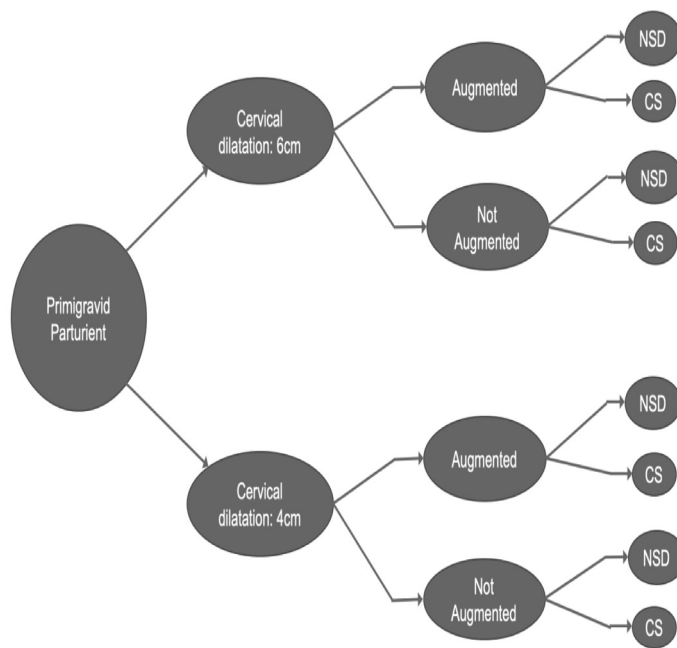
Figure 1. Study Design. Prospective Cohort

of cohort. (3) Proportion of parturient who utilized augmentation with oxytocin.

Study Design

Prospective Cohort

Sample Size

This is a study on 207 patients, a minimum of 194 parturient satisfying the inclusion/exclusion criteria should be included in the study based on 5% level of significance, 80% power, 14.8% rate of of cesarean section in Southeast Asia at ±5% precision (Beltran AP. at el, 2016).

Statistical Analysis

Summary statistics were presented in tables and reported as mean ± standard deviation or median (interquartile range) for quantitative continuous measures (e.g. maternal age, gestational age, hours of active labor for normal delivery) and as count (percent) for qualitative discrete measures (e.g. mode of delivery). Checks for homogeneity of sample population were performed. Shapiro-Wilks test was used to check for normality of continuous data. Independent t test or Mann Whitney U test was used to compare averages between Friedman's group (cervical dilatation 4cm) and Zhang's group (cervical dilatation 6cm). Fisher's exact test or Yate's chi-square test was used to compare proportions. Statistical significance was based on p-value ≤ 0.05. STATA v13 was used in data processing and analysis.

RESULTS

Of 207 primigravida, 21.3% had cervical dilatation of 4cm while 78.7% with cervical dilatation of 6cm. Table 2 presents the baseline socio-demographic, labor characteristics of women and fetal outcome. Average age was 18 years, range from 14 to 35 years. Compared with Zhang's group, greater proportion of those under Friedman's group were older than 24 years (18.6% vs 6.1%). Lower proportion under Friedman's group were single (88.6% vs. 98.2%). Most mothers completed primary education (50.7%) and unemployed (95.7%). Average gestational age was 38.9 weeks, range from 37 to 42 weeks. Average body mass index was 24 kg/m^2, range from 19.4 to 46.6 kg/m^2. Neonates had Apgar scores, range from 7 to 9. Majority of neonates had Apgar score of 8 at 1 minute (95.7%) while all infants had Apgar score of 9 at 5 minutes (100%). There was insufficient evidence to show significant differences between Zhang's and Friendman's group with respect to education, employment, gestational age, body mass index and infants' Apgar score. (Table 2)

Oxytocin for augmentation was used in nearly half of the women admitted under Zhang's group. Higher proportion of those under Friedman's group than Zhang's group had augmented labor (100% vs. 53.4%). (Table 3)

Majority of mothers underwent normal spontaneous delivery (94.7%). Greater proportion under Zhang's group had successful vaginal delivery (98.2% vs. 81.8%). Accounting for possible effects of maternal age, marital status and utilization of labor augmentation. (Table 4)

Average hours of active labor for normal spontaneous delivery was 3 hours, range from 2 to 6 hours. Parturients under Friedman's group had longer average hours of labor than those under Zhang's group (5 vs. 3 hours). Those under Friedman's group had hours of active labor from 4.5 to 6 hours, majority at 5 hours (77.8%) while those under Zhang's group from 2 to 4 hours, majority at 3 hours (85.6%). (Table 5)

Proportion of parturients who underwent cesarean section was 1.8% under Zhang's group versus 18.2% under Friedman's group. (Table 4)

The indications for cesarean section were as follows: (1) Arrest in cervical dilatation (2) Failure of descent and (3) Non-reassuring fetal status. Majority of patients under Friedman's group had cesarean section due to Arrest in cervical dilatation (62.5%) followed by Non-reassuring fetal status (25%) then lastly due to Failure of descent (12.5%). 66.7% of patients under Zhang's group had cesarean section due to Failure of descent, 33% due to arrest in cervical dilatation (Table 6).

Table 2. Socio-demographic, obstetric characteristics & fetal outcome of primigravida by cervical dilatation

Characteristic	All n = 207	Zhang's Criteria Cervical Dilatation 6cm n = 163	Friedman's Criteria Cervical Dilatation 4 cm n = 44	p-value
Age in years	18 (3)	18 (2)	18 (4)	0.102
<18	94 (45.6%)	79 (48.5%)[a]	15 (34.9%)[a]	0.034[*]
18-24	94 (45.6%)	74 (45.4%)[a]	20 (46.5%)[a]	
>24	18 (8.7%)	10 (6.1%)[a]	8 (18.6%)[b]	
Marital status				
Single	199 (96.1%)	160 (98.2%)[a]	39 (88.6%)[b]	0.012[*]
Married	8 (3.9%)	3 (1.8%)[a]	5 (11.4%)[]b]	
Educational attainment				
Elementary undergraduate	70 (33.8%)	58 (35.6%)	12 (27.3%)	0.436
Elementary graduate	105 (50.7%)	80 (49.1%)	25 (56.8%)	
High school graduate	30 (14.5%)	24 (14.7%)	6 (13.6%)	
College graduate	2 (1.0%)	1 (0.6%)	1 (2.3%)	
Employment status				
Employed	9 (4.3%)	9 (5.5%)	-	0.209
Unemployed	198 (95.7%)	154 (94.5%)	44 (100%)	
Gestational age in weeks	38.9 (1.9)	38.9 (1.7%)	38.9 (2.0)	0.615
37 to 37 6/7	42 (20.3%)	35 (21.5%)	7 (15.9%)	0.057
38 to 38 6/7	68 (32.9%)	51 (31.3%)	17 (38.6%)	
39 to 39 6/7	46 (22.2%)	42 (25.8%)	4 (9.1%)	
40 to 40 6/7	38 (18.4%)	25 (15.3%)	13 (29.5%)	
41 to 41 6/7	10 (4.8%)	8 (4.9%)	2 (4.5%)	
42	3 (1.4%)	2 (1.2%)	1 (2.3%)	
Body mass index in kg/m^2	24.0 (3.2)	23.9 (3.3)	24.7 (3.8)	0.615
18.5-24.9	129 (62.3%)	105 (64.4%)	24 (54.5%)	0.382
25-29.9	69 (33.3%)	52 (31.9%)	17 (38.6%)	
>30	9 (4.3%)	6 (3.7%)	3 (6.8%)	
Apgar score at 1 minute				
7	1 (0.5%)	1 (0.6%)	-	0.768
8	198 (95.7%)	155 (95.1%)	43 (97.7%)	
9	8 (3.9%)	7 (4.3%)	1 (2.3%)	
Apgar score at 5 minutes				
9	200 (100%)	161 (100%)	38 (100%)	0.929

Data presented as mean ± standard deviation or count (percent).
• Significant at 5% level
[a, b] Significant pairwise comparison

Table 3. Utilization of Labor Augmentation

Mode of Delivery	All n = 207	Zhang's Criteria Cervical Dilatation 6cm n = 163	Friedman's Criteria Cervical Dilatation 4 cm n = 44	p-value
Augmented	131 (63.3%)	87 (53.4%)[a]	44 (100%)[b]	<0.001*
Not Augmented	76 (36.7%)	76 (46.6%)[a]	-[b]	

Data presented as count (percent).
• Significant at 5% level
[a, b] Significant pairwise comparison

Table 4. Mode of delivery in primigravida by cervical dilatation

Mode of Delivery	All n = 207	Zhang's Criteria Cervical Dilatation 6cm n = 163	Friedman's Criteria Cervical Dilatation 4 cm n = 44	p-value
Normal spontaneous delivery	196 (94.7%)	160 (98.2%)[a]	36 (81.8%)[b]	<0.001*
Cesarean section	11 (5.3%)	3 (1.8%)[a]	8 (18.2%)[b]	
Data presented as count (percent). • Significant at 5% level [a, b] Significant pairwise comparison				

Table 5. Hours of active labor for normal spontaneous delivery in primigravida by cervical dilatation

Active Labor	All n = 196	Zhang's Criteria Cervical Dilatation ≥6cm n = 160	Friedman's Criteria Cervical Dilatation ≥4 cm n = 36	p-value
Active labor in hours	3 (2.0 – 6.0)	3 (2.0 – 4.0)	5 (4.5 – 6.0)	<0.001*
2	7 (3.6%)	7 (4.4%)[a]	-a	<0.001*
2.5	7 (3.6%)	7 (4.4%)a	-a	
3	137 (69.9%)	137 (85.6%)[a]	-b	
3.5	4 (2.0%)	4 (2.5%)[a]	-a	
4	5 (2.6%)	5 (3.1%)[a]	-a	
4.5	1 (0.5%)	-a	1 (2.8%)[b]	
5	28 (14.3%)	-a	28 (77.8%)[b]	
5.5	3 (1.5%)	-a	3 (8.3%)[b]	
6	4 (2.0%)	-a	4 (11.1%)[b]	
Data presented as median (range) or count (percent). • Significant at 5% level [a, b] Significant pairwise comparison				

Table 6. Indications of cesarean section in primigravida by cervical dilatation

Indication	All n = 11	Zhang's Criteria Cervical Dilatation 6cm n = 3	Friedman's Criteria Cervical Dilatation 4 cm n = 8
Arrest in cervical dilatation	6 (54.54%)	1 (33.3%)	5 (62.5%)
Failure of descent	3 (27.27%)	2 (66.7%)	1 (12.5%)
Non-reassuring fetal status	2 (18.18%)	0	2 (25%)
Data presented as count (percent).			

DISCUSSION

Results showed that there is significant difference noted with the sociodemographic characteristics considering the age and marital status (Table 2), factors known to affect labor progress and duration.[3] Population based cohort study was done by Kenny. et al. were the final study cohort consisted of 215,344 births; 122,307 mothers (54.19%) were aged 20–29 years, 62,371 (27.63%) were aged 30–34 years, 33,966 (15.05%) were aged 35–39 years and 7,066 (3.13%) were aged ≥40 years. Women aged 40 and above at delivery were at increased risk of stillbirth, pre-term and very pre-term birth,macrosomia, extremely large for gestational age and Caesarean delivery.[9]

In our study, 46.5% under Friedman's group was within an age bracket of 18-24, 34.9 % was <18 years of age. 48.5% under Zhang's group was age <18 years and 45.5% was within 18-24 years of age. Greater proportion had aged <24years old which is accountable to have contributed in success of vaginal deliveries and no documented feto-maternal complications.

According to Yazdani et al. higher body mass index increases the incidence of induction of labor, cesarean section, pre-term labor and macrosomia.[10] Thus higher proportion of spontaneous vaginal delivery in this study can be attributed to parturients having a normal body mass index.

There were no significant differences were noted as

to the apgar scores between the two groups.

In a retrospective cohort study, among 8,988 pregnant women in Shanghai China with singleton gestation, term live birth, vertex presentation, no previous cesarean section, they have investigated the expected labor progression after augmentation with oxytocin. The 50th (95th) centiles of the time interval from 4 to 5cm, 5 to 6 cm, and 6 to 10 cm dilation were 2.9 (8.8) hour, 1.7 (5.8) hour, and 2.1 (6.0) hour in nulliparas.[12] However in our study, the average hours of active labor from 6 to 10cm was 3 hours (2.0-4.0 hours). Consistent with our clinical experience, our data demonstrates that cervical dilatation accelerates as labor advances. The average hours of labor were also compared and we proved that parturients admitted under Zhang's group had less hours of active labor than those admitted under Friedman's group (3 vs. 5 hours). (Table 5)

After statistical analysis was made to determine the effectiveness of utilizing the Zhang's criteria, our study proved that there is statistically significant difference among those who delivered vaginally under Zhang's group compared to Friedman's group (p=0.001). Greater proportion of those admitted under Zhang's group had successful vaginal deliveries compared to those admitted under Friedman's group (98.2% vs. 81.8%) (p=0.011, OR=18.167, 95% CI: 1.943, 169.867). (Table 4). This study then suggests that 6cm rather than 4cm of cervical dilatation may be a more appropriate landmark for the start of the active phase of labor and thus criteria for admission.

Zhang et. al. conducted a retrospective study regarding the rate of cervical dilatation of 62,415 singleton cephalic vaginal deliveries with spontaneous onset of labor and normal neonatal outcome, the curve generated from his study proved to be different from Friedman's curve. It was not until at cervical dilatation of 6cm where abrupt increase in the rate of cervical dilatation was seen as compared to the 4cm cervical dilatation from Friedman's curve.[3] Since the most drastic changes in cervical dilatation are found in active phase, this is also the point wherein the obstetrician is more anxious for the labor to progress drastically as well. Thus, deviations from the normal Friedman's curve alarms the obstetrician and would decide to perform cesarean section on patients who could have undergone vaginal delivery.

Using the guidelines recommended by the American College of Obstetricians and Gynecologists in 2014, the following statements are specific recommendations that suggested lenience in comparison to the criteria given by Friedman. That is to consider the start of active-phase labor to be defined as cervical dilation of 6 cm instead of 4cm.[6] This has been the main starting point

for this study, for this decides when to start monitoring a patient's labor pattern and subsequent management. By admitting at least 6cm cervical dilatation, numbers of patients who underwent cesarean section had a significant difference to those who were admitted under Friedman's group as shown in the difference of proportion of cesarean section in this study (1.8% vs 18.2%; Table 4). Thus, helped preventing the patients to possibly acquire complications, morbidities and even mortalities from undergoing cesarean section.

Finally, since intrapartum cesarean deliveries were performed according to the prevailing definition of labor arrest, some cesarean deliveries may be performed too soon (before 6cm), which can cause early censoring of observation if admitted at 4cm cervical dilatation.[3] Based from the results of this study, arrest in cervical dilatation accounts for the top most indication for cesarean section admitted under Friedman's criteria (62.5%). Failure of descent was the most indication for cesarean section under Zhang's group (66.7%).

CONCLUSION

The rate of successful vaginal delivery is significantly different between the two groups. A greater proportion of pregnant women under Zhang's group achieved successful vaginal delivery as compared to Friedman's group.

Like wise, there is a significant difference between the two groups based on the following secondary outcomes (Zhang group versus Friedman's group): (1) The proportion of pregnant women who underwent cesarean section under the Zhang's group is lower versus the Friedman's group (1.8% vs 18.2%; p value <0.001) (2) There is less average hours of active labor for Zhang's group compared to Friedman's group (3 vs 5hours; p value <0.001) (3) Lower proportion of parturients under Zhang's group were augmented compared to Friedman's group (53.4% vs 100%)

No significant differences were noted as to the apgar scores between the two groups.

LIMITATION OF THE STUDY

The study explored its effectiveness of increasing the rate of vaginal delivery between two criteria's (Zhang vs Friedman) only among Primigravid patients.

RECOMMENDATIONS

We recommend another research study be done among multigravid patients employing the Zhang's criteria. Continuation of this research to a bigger scale

setting. Using the new guidelines as American College of Obstetricians and Gynecologists in 2014 should be advocated since no modification was made in the criteria for diagnosing abnormal labor patterns since the 1980s.

REFERENCES

1. F. Gary Cunningham, MD, Kenneth J. Leveno, MD, Steven L. Bloom, MD, et al. Williams Obstetrics and Gynecology 24th ed., USA: McGraw-Hill. Section 7.22 Normal Labor, page 811.

2. Zhang J et al. Re-assessing the labor curve in nulliparous women. *Am J ObstetGynecol*. 2002 Oct; 187:824-8.

3. Contemporary Patterns of Spontaneous Labor With Normal Neonatal Outcomes, Zhang et al. *Obstetrics & Gynecology*: December 2010-Volume 116 – Issue 6 – p 1281-1287.

4. Rouse DJ, Owen J, Hauth JC. Criteria for failed labor induction: prospective evaluation of a standardized protocol. *Obstet Gynecol*. 2000; 96:6717.

5. Peisner DB, Rosen MG. Transition from latent to active labor. *Obstet Gynecol*. 1986; 68:448-51.

6. American College of Obstetricians and Gynecologists (the College) and the Society for Maternal-Fetal Medicine with the assistance of Aaron B. Caughey, MD, PhD; Alison G. Cahill, MD, MSCI; Jeanne-Marie Guise, MD, MPH; and Dwight J. Rouse, MD, MSPH. "Safe prevention of the primary cesarean delivery. Obstetric Care Consensus No. 1." American College of Obstetricians and Gynecologists. *Obstet Gynecol*. 2014; 123:693-711.

7. Riitsuko Suzuki RNM, MN, Shigeko Horiuchi RNM, PhD, Hiroshi Ohtsu, MSc. Evaluation of the labor curve in nulliparous Japanese women. *AJOG*. September 2010, Pages 226.e1-226.e6.

8. Advanced Maternal Age and Adverse Pregnancy Outcome: Evidence from a Large Contemporary Cohort. Louise C. Kenny, Tina Lavender, Roseanne McNamee, Sinéad M. O'Neill, Tracey Mills, Ali S. Khashan. February 20, 2013. https://doi.org/10.1371/journal.pone.0056583.

9. Shahla Yazdani, Yousofreza Yosofniyapasha, Bahman Hassan Nasab, Mohsen Haghshenas Mojaveri, and Zinatossadat Bouzari. Effect of maternal body mass index on pregnancy outcome and newborn weight. 2012 Jan 17. doi: 10.1186/1756-0500-5-34.

10. The expected labor progression after labor augmentation with oxytocin: A retrospective cohort study. Zhang L1,2, Troendle J3, Branch DW4, Hoffman M5, Yu J1, Zhou L1, Duan T6, Zhang J2. 2018 Oct 31.