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Comparative Study to evaluate the superiority of MRI imaging modality over ultrasound in diagnosis of Placenta Previa in second stages of pregnancy

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Abstract— **Introduction:** Placenta Previa (PP) is a pathological condition defined as displacement of placenta to the cervical region. The purpose of this study is to evaluate the superiority of magnetic resonance imaging (MRI) over ultrasound (US) in diagnosing of placenta Previa (PP) in second stages of pregnancy, and to determine morbidity association with PP. **Materials and Methods**: This retrospective study includes 65 cases of pregnant women with PP. The cases collected from six different hospitals in Riyadh. The results of MRI and US of PP cases compared with post-operative data. The patients' files reviewed for assessment. **Results:** Chi-square and Cross-tabulation statistical tests used. The Statistical information of PP patients shows that age group 29-39 have the highest frequency of PP with associated grade IV, and there is significant Relation between age and grade where P= 0.001% < 0.05 % (from chai square test). Result shows that the degree of PP is age dependent. Increta association has highest frequency with PP on imaging MRI modality. Almost half of the cases have no association with PP. These results are evidence that MRI is superior in diagnosing PP over US. **Conclusions:** The MRI and US are the prime choices for diagnosing abnormal placentation. MRI has the superiority in diagnosing PP over US based on the collected medical reports, and reviewed MRI as well as US image. The results of this study indicate that the relationship between age and PP grade complication is significant and shows an excellent diagnosis through different planes of MRI.

Keywords: Placenta Previa, MRI, US, Third stage of pregnancy

1. Introduction

Placenta Previa (PP) is a pathological condition defined as displacement of placenta to the cervical region (1). The placenta is the first organ to be developing during the growth of a fetus and it has several fascinating, as well as critical functions (2). The placenta is a disc-shaped organ which weighs almost 500 g, has a diameter of 15–20 cm, a thickness of 2–3 cm, and a surface area of almost 15m^2(5). The organ is responsible for delivering oxygen and nutrients to the fetus from the mother. The most common Symptoms of PP is painless vaginal bleeding, risk factors increase when other factors are involve such as age or smoking.

Referencing a previous study conducted in 2016, it reports that PP occurs in 15% of Saudi pregnant females (2) and it varies in degree and location. Thus, PP can be classified into four types (Grade I- IV) based on the location of the placenta relative to the cervix (2). In grade I, known as low-lying placenta, the placenta lies in the lower uterine segment, but its lower edge does not reach the internal cervical. In grade II, known as marginal Previa, the placental tissue reaches the margin of the internal cervical but does not cover it. In grade III, known as partial Previa, the placenta partially covers the internal cervix. In grade IV, known as complete Previa, the placenta completely covers the internal cervix. Sometimes grades I and II are termed "minor" or "partial" placenta Previa, and grades III and IV are termed "major" placenta Previa (3-5).

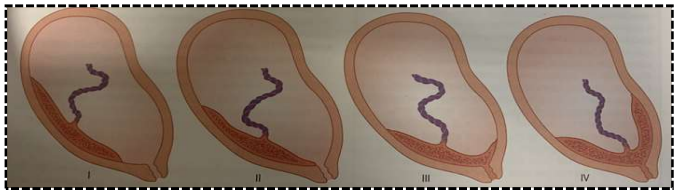
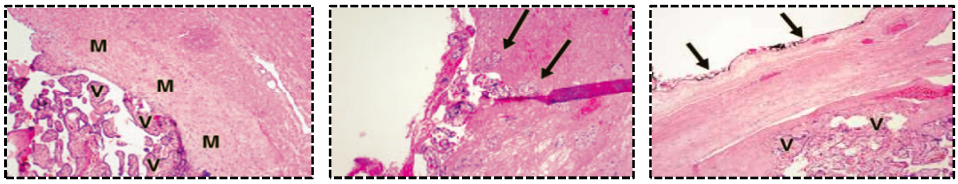


Figure1.1: placenta Previa grade. (3)

"Morbidly adherent placenta" (MAP) is the invasion in the deep uterine; it is commonly associated with PP. It can classify to the fourthdegree, which are Placenta accreta, increta and percreta. Placenta accreta is abnormal placental attachment in the decidua basalis, the placental chorionic villi invasion and attached to the myometrium (Figure 2-a). Placenta increta is abnormal attachment to the deep of three the myometrium invades by placental chorionic villi (Figure 2-b). Placental Percreta is abnormal placental attachment in the complete penetration of the myometrium by placental chorionic villi, which extends to the serosa, and causes hemorrhage (Figure 1.2-c). (6).



(A) (B) (C)

Figure 1.2: A: placenta accrete chorionic villi (V), myometrium (M). B: placenta increta invasion of chorionic villi (V) (arrows) into myometrium. C: placenta Percreta chorionic villi (V), fibro vascular tissue remains between placental villi and uterine serosal surface (marked by black ink) (arrows). (7)

1.2 Diagnostic Modalities

1.2.1 Magnetic Resonance Imaging Scanner (MRI)

Magnetic Resonance Imaging [MRI] scanning is a non-invasive and painless procedure using a large magnet, radio waves, and a computer to create a detailed cross-sectional image of internal organs and structures. The machine typically consists of large scannerscontaining magnetic field coils, transmitting and receiving coils, and a table in the middle to allow patients inside the magnet.

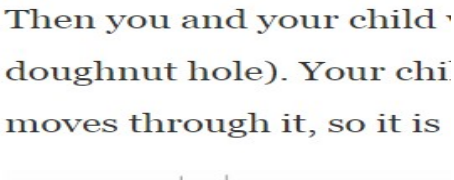


Figure 1.3: MRI Scan Machine (8).

1.2.2 Ultrasound Machine (US)

Ultrasound (US) scan is a noninvasive technique using high frequency sound waves that can bounce off tissues through special devices, the waves bouncing off tissues produce echoes that convert into a picture entitled a sonogram. It shows an inside view of body cavities and soft tissue.

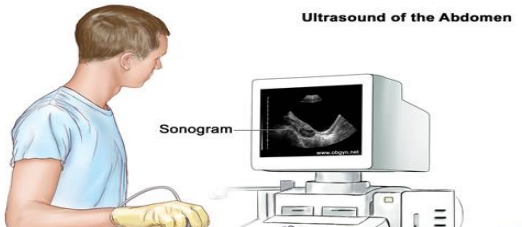


Figure 1.4: US Scan Machine (9).

2. Methodology:

2.1 Data Collection Methods

This data is a retrospective and observational study on Saudi women diagnosed with placenta Previa. This data comes from different hospitals and medical centers in the capital of Saudi Arabia, Riyadh. The thesis journey took us 4 months (Nov 1st 2020 to Mar 1st 2021). The data was collected through medical reports and reviewed MRI as well as US images. Furthermore, patients' information including age, trimester, medical history, all relevant-clinical data (signs and symptoms), radiological data related to anatomical of the placenta, and all other findings affecting the case diagnosis was included. The method of data collection was performed under the criteria that would be most beneficial for placenta Previa.

2.2 Sample Size Calculation This study sample calculation's basis is froma web sample calculator, which uses the following equation:

$$\frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Where N = population size, e = Margin of error (percentage in decimal form), and z = z-score. The z-score is the number of standard deviations a given proportion is away from the mean. For example, if the desired confidence level is 95% (as we chose for this study), then the z-score is 1.96(10). The information used for the sample size of this project goes as follows:

1-Saudi population is 33,299,934 million (11).

2-Females under 40 years old are 32% of Saudi population.

Which is 32÷100×33,299,934 = 10,655,978 females. This calculation agrees confirms the 2016 Saudi statistical study, stating that Saudi females' population in bearing age stage is 10,655,978 (11). Dr. Itedal Ahmed (11) reported that 15% of Saudi pregnant females suffer from PP during their pregnancy. The PP population can be calculated by multiplying this percentage with 10,655,978 ,the Saudi female population in bearing age from 30-40 years old.

3-PP female population = 10,655,978 × 15 ÷ 100 = 1,598,396. This number used to calculate the sample size of this study using website formula (10); with confidence level of 95% and an error estimation of 5%. The resulted sample size calculation is 385 for this study. However, the reported sample size will be less than this number due to the limited time and area of data collection (Riyadh only).

2.3 Data Analysis Methods

Patient's information obtained from patient's files, and statistical package for social science (SPSS) program used along with excel sheet to test the correlation between PP and other parameters such as age, associated complications, and method of diagnosis. Chi-square and Cross-tabulation used to test the relationship between the variables. Chi-square ($\chi 2$) test of independence can provide information on the significance of the relations between PP and the tested variables (12), and calculated as following

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(A_{ij} - E_{ij})^2}{E_{ij}}$$

Where: Aij = Actual frequency in row i and column j Eij = Expected frequency in row i and column j r = number of rows c = Number of columns

3. Data Analysis and Result

Out of 65 pregnant women diagnosed with placenta Previa, only 35 diagnosed with associated abnormal placentation, and 30 diagnosed with placenta Previa with no associated abnormal placentation.

Tables 3.1 and 3.2 represent the statistical distribution between age and grade for PP, and the frequency of age dependent for PP respectively.

Statistics			
		Distribution of Age	Grade
N	Valid	65	65
	Missing	0	0

Table 3.1: Statistical distribution with relation to patient age and grade in pp

Distribution of Age					
		Frequency	Percent	Valid Percer	Cumulative Percen
Valid	18-28	9	13.8	13.8	13.8
	29-39	46	70.8	70.8	84.6
	40-50	10	15.4	15.4	100.0
	Total	65	100.0	100.0	

Table 3.2: Frequency table of distribution age.

Grade					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Grade I	8	12.3	12.3	12.3
	Grade II	6	9.2	9.2	21.5
	Grade III	4	6.2	6.2	27.7
	Grade IV	47	72.3	72.3	100.0
	Total	65	100.0	100.0	

Table 3.3: Frequency table of grade placenta Previa.

Tables 3.1 to 3.3 contain statistical information about 65 cases, where Table 3.2 shows that age group 29-39 with the highest frequency of PP, and it is grade IV type which seen in table 3.3

Test Statistics		
	Distribution of Age	Grade
Chi-Square	41.015a	78.077b
Df	2	3
Asymp. Sig.	.000	.001

Table 3.4: CHISQ table between age and grade of placenta Previa (PP).

Table 3.4 shows the results of Chi-square tests relating the relationship between age of pregnant patient with placenta Previa with grade of placenta Previa.

As we can see from this table the observed N of group 29-39, which has the highest number of women with grade IV (shown in Table 3.3). The chi-square test from Table3.4 shows significant relation between age and grade of PP, where P= 0.001% < 0.05%, which indicates that the degree of placenta Previa is age dependent.

Statistics			
		Attach	Modality
N	Valid	65	65
	Missing	0	0

Table 3.5: Statistical distribution relates patient complication to modality of diagnosis.

Attach					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Accreta	9	13.8	13.8	13.8
	Increta	15	23.1	23.1	36.9
	Percreta	11	16.9	16.9	53.8
	None	30	46.2	46.2	100.0
	Total	65	100.0	100.0	

Table 3.6: Frequency test of complication.

Tables 3.5 and 3.6 present the statistical relation between the PP cases and method of diagnosis, and the relation between PP complications and their attachments respectively. As one can be seen from Table 3.6 increta complication has highest frequency with placenta previa in imaging by MRI modality.

Modality					
		Frequency	Percent	Valid Percen	Cumulative Percent
Valid	Ultrasound	19	29.2	29.2	29.2
	MRI	46	70.8	70.8	100.0
	Total	65	100.0	100.0	

Table 3.7: Frequency test of modality.

Tables 3.7 displays the frequency test of the used modalities (MRI and US) for the selected PP cases. In Table 3.8, the distribution of PP grades and the associated complications are displayed. The SPSS software generates these tables when the Chi-square is applied to the selected data.

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Grade * Attach	65	100.0%	0	0.0%	65	100.0%

Table 3.8: Distribution between placenta Previa (PP) grades and complications.

The cross-tabulation test of the PP grades and the associated complications presented in Table 3.9, where one can see that the highest complications are associated with PP grade IV.

Grade * Attach Cross-tabulation						
Count						
		Attach				Total
		Accreta	Increta	Percreta	None	
Grade	Grade I	1	1	3	3	8
	Grade II	1	1	0	4	6
	Grade III	1	0	0	3	4
	Grade IV	6	13	8	20	47
Total		9	15	11	30	65

Table 3.9: Grade IV PP has the highest complication increta, as you can see from the table; there are 13 cases for grade IV.

Test Statistics		
	Grade	Attach
Chi-Square	78.077a	16.662a
Df	3	3
Asymp. Sig	.000	.001

Table 3.10: CHISQ table between grades and complication of placenta Previa (PP).

Table 3.10 shows CHISQ test between grades and complication of placenta Previa, the result is significant where P=0.01% < 0.05% indicating a strong relation between PP grades and complication.

(A) (B)

Figure 3.1: A: MRI image one of our cases in age 33 with PP associated with Increta. B: US image one of our cases in age 33 with PP grade IV.

4. Discussion

The current work is a retrospective study to determine the superiority of MR imaging in evolution of placenta Previa compared to US, and the relations between PP grades and its associated complications. MRI and US are the confirmed modality of choice to evaluate the placenta abnormality. Al Ibrahim (13) stated that the first imaging modality used to evaluate suspected abnormal placentation is US. However, current research show that MRI is the first line of evolution to examine the grade, age, and association dependency of placenta Previa based on the collected data of 46 cases evaluated by MRI, whereas US only diagnosed 19 cases.

The medical file of the collected data presents the type of modality used for case diagnosis in most cases. Especially when PP complications are suspected (MAP). A greater portion of the diagnoses researched are based on MRI pelvis imaging protocols, where various sequences used including STIR, FFE,T1 and T2 weighted images with axial, coronal and sagittal views (14). A study published by john R et al, at US (7), stated that if the suspected presence of an abnormality in the placenta, based on the initial survey, the selection of more imaging projection gives better image of interface in the muscular surface of said abnormality, or other inner structures of the pelvis. Therefore, they rely on different techniques that show the anatomy of the fetus and clearly show the boundaries between the placenta and the uterus alike, weighted T2 echo sequence.(7)

In this study, 65 cases of pregnant women with placenta Previa (pp) are studied. The range of ages between the females studied is 29 to 39 years old. There is a significant relationship between age and PP grades, and this theory is proven by a study conducted by Arul Anne Rose (15) stated that older women had more frequent diagnoses of placenta previa than younger patients did. In contrast to Anne's study, Zahra Roustaei (16) directed a study in defiance to her findings, reporting that allegedly age had nothing to do with increased risk factors of placenta Previa. However, in this study they found that pregnant women who do suffer from placenta Previa are also sustaining blood transfusion complications along with placental abruption more than younger pregnant women with placenta Previa. This could dispute the theory of age increasing the risk factor of PP.

Placenta increta is a severe pregnancy condition in which the placenta attaches itself too deeply into the myometrium, which is the second stage of morbidly adherent placenta (17). The presented study observed relationships between grades and complications of placenta Previa based on ultrasound and MRI imaging. Thirteen patients among the studied cases have their internal cervix (grade IV) completely covered by the placenta, placenta Previa is significantly higher with Placenta increta than in the accreta or Percreta. However, during placenta increta there were no cases where the placenta partially covered the internal cervix (grade III). The results of this study found a significant relation between grades and complications, which means patients with higher PP grades will have complications.

These findings are consistent with a previous study by Alamo at el (18), which confirms that placenta accreta is the most frequent and less severe form, caused by the penetration of the decidua by the chorionic villi. Placenta increta consists of a partial invasion of the myometrium through the villi, and placenta Percreta is the most severe form. The appearance of placenta accrete, and increta on MRI images is the most difficult to spot when diagnosing due to the values on the diagnostic being low. Unlike the management of placenta Percreta, which is usually significant hemorrhages during labor.
Cross-tabulation statistical used to evaluate the relationship between placenta complication and grades for the collected data.

The results showed an association between placenta complication and grade, where the increase of the grade level will increase risk, and higher rate of complications of placenta due to deeper of the invasion, these findings are in agreements with Alamo published study (18). Alamo and colloquies recommend using MRI

for suspected placental invasion if possible since MRI features have defined in association with placental complication, and this agrees with the study suggestion. They also conclude that MRI placenta should be a complementary modality to US for managing patients at risk of placenta invasion. This research supports this suggestion.

5. Conclusion

Based on this research, and the carried statistical analysis, we can conclude that MRI has the superiority in diagnosing placenta Previa on US, and there is strong correlations between PP grades, age, and associated complications such as accreta, Percreta, and increta. Where Chi-square result of the relation between PP and these variables is significant .Future research could explore the faster and better method of evaluating PP in different pregnancy stages and the relation of age, and grade complications.

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