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Role of Uterine Artery Doppler in Diagnosis of Placenta Accreta in Cases of Placenta Previa

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ABSTRACT
Background: Placenta accreta occurs when there is an abnormal adherence of a part or entire of the placenta to the uterine wall with either partial or complete absence of the decidua basalis.
Objective: This study aimed to investigate the role of uterine artery Doppler in the diagnosis of placenta accreta in patients with placenta previa.
Patients and method: This study prospective cohort study was done at Maternity Hospital, Zagazig University. The study included 36 pregnant women with placenta previa attending for antenatal care or emergency department. All patients were subjected to full history taking, ultrasound examination and colour Doppler was performed using: VOLUSION 730 prov (2D Doppler) of 5 MHZ**.**
Result: The main gray scale ultrasound features were presence of vascular lacunae with a sensitivity of 96% and specificity of 89.1%, absence of RPS with a sensitivity of 76% and specificity of 32.7%, myometrial thinning with a sensitivity of 76% and specificity of 34.51%, absence of RPS and vascular lacunae with a sensitivity of 80% and specificity of 56.4%, absence of RPS and myometrial thinning with a sensitivity of 82.2% and specificity of 56.5% and myometrial thinning and vascular lacunae with a sensitivity of 76.4% and specificity of 34.5%. All signs with a sensitivity of 68% and specificity of 96.4%.
Conclusion: The use of gray scale ultrasound and colour flow Doppler is a good tool in diagnosis of placenta previa accreta. Addition of uterine artery Doppler indices could predict placenta accreta in cases of placenta previa.
Keywords: Color Doppler, Uterine artery, Placenta accreta, Placenta previa accrete.

INTRODUCTION

Placenta accreta (PA) occurs when there is an abnormal adherence of a part or entire of the placenta to the uterine wall with either partial or complete absence of the decidua basalis. The placenta may be abnormally adherent to the myometrium or extend to invade other tissues (uterine serosa or urinary bladder) **(1).**

Placental attachment is classified according to degree of penetration to myometrium. Placenta accreta (invasion of placental tissue into the decidual surface of the myometrium), placenta increta (placental villi invade more deeply within the myometrium), and placenta percreta when chorionic villi penetrate through the uterine serosa and may invade surrounding organs such as the bladder **(2).**

One of the catastrophic complications of PA is massive hemorrhage at the time of placental separation, which can lead to shock, renal failure, adult respiratory distress syndrome, and even death. In severe cases, hysterectomy may be required, also urinary bladder or ureteral injury and pulmonary embolism are other serious complications **(3)**.

Incidence of placenta accreta is one per 1,533 pregnancies that was noted by **Wu *et al.* (4)**. Since placenta accreta cannot be prevented and because the incidence is rising because of fewer vaginal births after cesarean delivery (VBAC) trials as well as patient desire for elective cesarean delivery. Antenatal diagnosis is important to allow effective planning to minimize maternal/fetal morbidity **(5).** Three per 1000 deliveries were placenta accreta and increase in the incidence of placenta accreta over the past decades **(6).**

Diagnosis of placenta accreta can be done by different modalities such as ultrasound grey scale, color Doppler, magnetic resonance imaging (MRI). Ultrasonography is usually employed as the primary modality for antenatal diagnosis of invasive placentation. Specific sonographic features of placenta accreta appear as loss of retro placental hypoechoic clear zone, loss of bladder wall uterine interphase, presence of placental lacunae (vascular spaces), and presence of hyper vascularity of interphase between the uterine serosa and bladder wall **(7).**

Previous uterine artery Doppler studies have suggested that a high uterine artery pulsatility index (PI) might be an indirect sign of impaired placentation **(8).** However, the relationship between placenta accreta and uterine artery Doppler velocimetric measurements have not been investigated previously **(9)**. The aim of this study was to investigate the role of uterine artery Doppler in the diagnosis of placenta accreta in patients with placenta previa.

PATIENT AND METHODS

This prospective cohort study was conducted on 36 female pregnant women with placenta previa attending for antenatal care or Emergency Department at Maternity Hospital, Zagazig University.

Inclusion criteria: Singleton pregnancy. Gestational age from 28 week till full term (last menstrual period and/or ultrasound confirmation of gestational age). Patient diagnosed as having placenta previa.

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Exclusion Criteria: Multiple gestational pregnancies, fundal placenta, gestational age less than 28 week, and associated medical disease affecting Doppler waves.

Sample size: Assuming the mean PI was 0 .56 ± 0. 09 vs ± 0.50.04 in ant. placenta previa vs ant. placenta previa accreta. At 80% power and 95% CI, the estimated sample was 36 cases.

All the women in this study were subjected to complete history taking, physical examination, investigations [included blood group & Rh type, complete blood picture, assessment of coagulation system (prothrombin time, prothrombin concentration, partial thromboplastin time and international normalized ratio), liver function tests (liver transaminase level, serum albumin level), and kidney function tests (serum creatinine and blood urea nitrogen)].

Ethical approval:

Written informed consent was obtained from all participants and the study was accepted by the Research Ethics Committee, Faculty of Medicine, Zagazig University. Study has been carried out on experiments involving human subjects in compliance with the Code of Ethics of the World Medical Association (Declaration Helsinki).

Transabdominal ultrasound:

The women were placed in supine position and examination was performed with the bladder filled, which allowed optimal visualization of the uterine serosa and the bladder wall. Ultrasound examination and colour Doppler were performed using: VOLUSION 730 prov (2D Doppler) of 4-8 MHZ. US to detect, fetal viability, gestational age, fetal weight, amniotic fluid index, turbidity and placental localization. To analyze the angioarchitecture of the lower uterine segment and placenta, we carried out a 2 dimension colour Doppler examination targeted to this region. The lateral view was used to observe the intraplacental vasculature and serosa–bladder complex along the sagittal axis of the maternal pelvis, and the basal view illustrated the serosa–bladder interface in a 90° rotation of the lateral view (observing from the direction of the bladder).

Assessment of uterine artery Doppler:

For the uterine artery Doppler studies, a sagittal section of the uterus was obtained, and the cervical canal and internal cervical os were identified. Subsequently, the transducer was gently tilted from side to side and color flow mapping was used to identify each uterine artery along the side of the cervix and uterus at the level of the internal os. Pulsed wave Doppler imaging was used with the sampling gate set at 2 mm to cover the whole vessel and care was taken to ensure that the angle of insonation was less than 30°. When three similar consecutive waveforms had been obtained. The PI and RI were measured on both sides and the mean values of the left and right arteries was calculated.

Colour Doppler findings of placenta accreta:

Diagnosis of placenta accreta depends on presence of two or more of these findings: Turbulent blood flow extending from the placenta into surroundings (focal or diffuse intraparenchymal placental lacunae flow), vesico-uterine serosal interphase hypervascularity, prominent retroplacental venous complex and loss of retroplacental space.

Follow up: Cases were followed up till intraoperative diagnosis confirmation.

Outcome measures: Correlation between ultrasound and Doppler findings and intra operative findings.

Statistical analysis

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures were coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. According to the type of data, qualitative data were represented as number and percentage and quantitative continues group was represent by mean ± SD. The following tests were used to test differences for significance; difference and association of qualitative variable by Chi square test (X^2). Differences between quantitative independent groups by t test or Mann Whitney test, agreement by Kappa, predictors by logistic regression. P value ≤ 0.05 was considered significant.

RESULTS

In this study, placenta accreta and its variants (including accreta, increta and percreta) were confirmed in 12 patients at the time of Cesarean delivery. The definitive diagnosis of placenta previa without invasion was made in 24 patients from 36 patients.

Table (1) showed that the mean age of the studied groups was statistically insignificant, it was 31.73 in placenta previa with invasion and 29.87 years in placenta previa without invasion, it also showed that there was statistically significant difference between both groups when compared for number of CS and highly significant difference between them is respect to parity with higher parity in placenta accrete.

Table (1): Demographic features of the studied group from parity, age and number of caesarian section

	Placenta previa with invasion n=(12)			Placenta previa without invasion n=(24)			T-test	
	Mean	±	SD	Mean	±	SD	T	P-value
Parity	3.23	±	0.81	2.29	±	0.92	5.190	<0.001*
Age	31.73	±	5.49	29.87	±	4.99	1.896	0.060
number of P.CS	2.64	±	0.31	2.16	±	0.17	2.167	0.032*

Data are expressed as mean **p< 0.001= highly significant. **p< 0.05= significant. N.B. Maternal age (years). P.CS=Previous Cesarean section.

The main finding that suspect placenta accreta was the location of placenta anteriorly by 100% in contrast the location of placenta posterior (Table 2).

Table (2): Ultrasonographic features of the studied patients (No = 36)

Ultrasonographic features	N (%)	Intra – operative findings		T/x^2	P
		Not accreta (24 patients)	Accreta (12 patients)		
Placenta location					
Anterior	20 (55.6%)	8 (33.3%)	12 (100%)	19.7	0.00 (H.S)
Posterior	16 (44.4%)	16 (66.7%)	0 (0.0%)		
Distance from internal os					
Complete centralis	5 (13.8%)	0 (0.0%)	5 (41.6%)	35.8	0.00 (H.S)
1 cm	16 (44.4%)	11 (45.8%)	3 (25%)		
<2cm	8 (22.2%)	8 (33.3%)	2 (16.6%)		
<4cm	7 (19.4%)	5 (20.8%)	2 (16.6%)		

The main gray scale ultrasound feature was presence of vascular lacunae with a sensitivity of 96% and specificity of 89.1%, absence of RPS with a sensitivity of 76% and specificity of 32.7% , myometrial thinning with a sensitivity of 76% and specificity of 34.51%, absence of RPS and vascular lacunae with a sensitivity of 80% and specificity of 56.4%, absence of RPS and myometrial thinning with a sensitivity of 82.2% and specificity of 56.5% and myometrial thinning and vascular lacunae with a sensitivity of 76.4% and specificity of 34.5. All signs with a sensitivity of 68% and specificity of 96.4% (Table 3).

Table (3): Ultrasonographic signs suggesting placenta accrete in 36 patients.

Ultrasonographic Criteria associated with accreta	Intra-operative finding						
	Number of patients	Not accrete	accreta	+ve P.V. %	-Ve P.V. %	Sensitivity %	Specificity %
Absence of RPS*	-Ve 22	18 (75%)	4 (33.3%)	33.9%	75%	76%	32.7%
	+ve 14	6 25%	8 66.7%				
Vascular lacunae	-Ve 9	8 33.3%	1 8.3%	80%	98%	96%	89.1%
	+ve 27	16 66.7%	11 91.6%				
Myometrial thinning	-Ve 11	8 33.3%	3 25%	34.5%	76%	76%	34.5%
	+ve 25	16 66.7%	9 75%				
Absence of RPS and Vascular lacunae	-Ve 22	15 62.5%	7 58.3%	43.4%	86.1	80%	56.4%
	+ve 14	9 37.5%	5 41.7%				
Absence of RPS and Myometrial thinning	-Ve 25	16 66.7%	9 75%	46.2%	87.1%	82.2%	56.5. %
	+ve 11	8 (33.3%)	3 (25%)				
Myometrial thinning and Vascular lacunae	-Ve 12	9 (37.5%)	3 (25%)	34.7%	76.5%	76.4%	34.5%
	+ve 24	15 (62.5%)	9 (75%)				
All signs	-Ve 19	16 66.7%	3 25%	89.4%	86.8%	68%	96.4%
	+ve 17	8 (33.3%)	9 (75%)				

*RPS=Retroplacental space *+ve P.V =Positive predictive value. *-ve P.V =Negative predictive value.

The sensitivity of turbulent blood flow extending from the placenta into the surrounding tissues in placenta accrete was 84%, followed by vesicouterine serosal hypervascularity that was 75%, then the focal or diffuse intraparenchymal placenta blood flow, which was 66.7 %, turbulent b1ood flow from the placenta into the surrounding and vesicouterine serosal hypervascularity was 80%, turbulent b1ood flow from the placenta into the surrounding and focal or diffuse intra parenchymal placenta blood flow was 80.2 % and focal or diffuse intra parenchymal placenta blood flow and vesicouterine serosal hypervascularity was 80.01. All these finding were found aggressively together in many cases by 83.4% to confirm diagnosis of placenta accrete (Table 4).

Table (4): Diagnostic criteria by Doppler that suggesting placenta accreta (No= 36 patients)

Doppler Criteria associated with accrete	**Intra-operative finding**						
	Number of patients	**Not accreta**	**accreta**	**+ve P.V. %**	**-Ve P.V. %**	**Sensitivity %**	**Specificity %**
Turbulent b1. flow from the placenta into the surrounding	-Ve 10	7 29.2%	3 25%	40%	88%	84%	40%
	+ve 26	17 70.8%	9 75|%				
Focal or diffuse intra parenchymal placenta blood flow	-Ve 13	9 37.5%	4 33.3%	33.3%	71.4%	66.7%	45.5%
	+ve 23	15 62.5%	8 66.7%				
Vesicouterine serosal hypervascularity	-Ve 14	10 41.6	4 33.3%	37.5%	62.5%	75%	55.5%
	+ve 22	14 58.4	8 66.7%				
Turbulent b1. flow from the placenta into the surrounding and Focal or diffuse intra parenchymal placenta blood flow	-Ve 18	15 62.5%	3 25%	57.3%	88.1%	80.2%	72.7%
	+ve 18	9 37.5%	9 75%				
Turbulent b1. flow from the placenta into the surrounding and Vesicouterine serosal hypervascularity	-Ve 19	16 66.7%	3 25%	57.1%	88%	80%	72.8%
	+ve 17	8 33.3%	9 75%				
Focal or diffuse intra parenchymal placenta blood flow and Vesicouterine serosal hypervascularity	-Ve 20	16 66.7%	4 33.3%	57.2%	88.11%	80.01%	72.81%
	+ve 16	8 33.3%	8 66.7%				
All signs	-Ve 26	24 100%	2 16.6%	100%	91.7%	83.4%	85.5%
	+ve 10	00 00	10 83.4%				

In comparison between the two studied groups, as regards the mean resistive and pulsatility indices of uterine arteries, these indices were statistically significant lower in placenta accrete than in not being accrete as shown in table (5).

Table (5): Doppler indices of uterine artery in studied groups

Doppler indices of uterine artery	**Not accreta (24 patients)**	**Accreta (12 patients)**	**P value**
RI (Mean ± SD)	0.022 ±0.45	0.01±0. 40	0.04 (S)
PI (Mean ± SD)	0.01± 0.56	0.01±0.50	0.00 (H.S)

**p< 0.001= highly significant. **p< 0.05= significant.

Table (6) showed that most of cases were managed conservatively by Caesarean section in 80.5%.

Table (6): Type of surgery in studied population

Variable	(N=36)	
Surgical Management	**N**	**%**
C.S only	29	80.5
Caesarean hysterectomy	7	19.4

Placenta was separated in 29 cases. Operators succeeded in conserving uterus by these procedures, but failed in 7 cases to manage hemorrhage and proceeded to hysterectomy. Table (7) showed that the most prevalent procedure was done to control bleeding from placental bed after placental separation was bilateral uterine artery ligation by a percent of 90%.

Table (7): Intraoperative procedures performed to control bleeding from placental bed after placental separation

Variable	(N=36)	
Procedure	**N**	**%**
Bilateral uterine artery ligation	18	90
Uterine packing	7	35
Bilateral Internal iliac artery ligation	2	10
Hemostatic sutures in placental bed	9	25

Table (8) showed that the most prevalent intraoperative complication was bladder injury by a percent of 13.8%. This was due to presence of excessive pelvic adhesions and difficult bladder dissection.

Table (8): Intraoperative complications of the studied population

Variable	(N=36)	
Injury	**N**	**%**
Bladder injury	5	13.8
Intestinal injury	1	2.7

DISCUSSION

In our study the mean age of placenta previa with invasion group was 31.73 years and placenta previa without invasion was 29.87 years, so age is not significant in this study. The mean of the parity of placenta previa with invasion group was 3.23 and placenta previa without invasion was 2.29 with high significance (p value <0.001). The mean of the number of P.CS of studied group of placenta previa with invasion was 2.64 and placenta previa without invasion is 2.16 with significant difference (p value < 0.032). So, parity and P.CS were significant. These results disagree with **Yang *et al.*** [10] who reported increased mother age. However, this study agrees with **Paul *et al.*** [11] in maternal age that was not found to be a predisposing factor for placenta previa. In this study parity was significant factor for placental adherent disorders that disagrees with **Paul *et al.*** [11] who found that parity is not a predisposing factor for placenta previa.

In this study, we used the transabdominal ultrasound and colour Doppler in diagnosis of placenta accreta, which agrees with **Elhawary *et al.*** [12] who used the same diagnostic tools.

In this study, the sensitivity and specificity of abnormal placenta lacunae were 96% and 89.1%. Absence of RPS showed a sensitivity of 76% and specificity of 32.7%, myometrial thinning showed a sensitivity of 76% and specificity of 34.51%, absence of RPS and vascular lacunae showed a sensitivity of 80% and specificity of 56.4%, absence of RPS and myometrial thinning showed a sensitivity of 82.2% and specificity of 56.5% and myometrial thinning and vascular lacunae showed a sensitivity of 76.4% and specificity of 34.5. All signs showed a sensitivity of 68% and specificity of 96.4%. This agrees with **Hoxhaj *et al.*** [13] who reported that sonographic criteria are dilatation of intervillous lacuna in suprabasal area, uneven maternal placental surface, a significant myometrial thinning and an abnormal vascularity in the placental zone are important for diagnosis of placenta accreta.

Comstock *et al.* [14] reported that clear space should not be used as a single diagnostic criterion, but should be combined with other criteria. **Shabana *et al.*** [15] agrees with our study where they reported that lack of clear zone was strongly associated with adherence of the placenta. However, we should be aware of the fact that placenta lacunae and lack of clear zone were frequently observed in placenta previa even if adherences of the placenta were not complicated and differentiation depended on the work to evaluate appearance of placenta lacunae and lack of clear zone in placenta previa compared to normal placenta in all women.

In this study, a pattern of turbulent blood flow extending from the placenta into the surrounding tissues has been reported in placenta accrete by 84%, followed by vesicouterine serosal hypervascularity by 75%, then the focal or diffuse intraparenchymal placenta by 66.7%. All these finding were found aggressively together in many cases by 83.4% to confirm diagnosis of placenta accreta. **Elhawary *et al.*** [12] reported that abnormal vascularization by colour Doppler ultrasound has the best combination of sensitivity and specificity and its localization at the uterus–bladder interface has the best sensitivity of placental invasion, which agrees with our study.

The sensitivity of colour Doppler and ultrasound in diagnosis of placenta previa accreta are 80% and 86% respectively, while the specificity was 85.5%, 96% respectively. The accuracy of colour Doppler and ultrasound were 95%, 90%. This agrees with **American College of Obstetricians and Gynecologists** [16] where its sensitivity has been reported in the range of 77% to 87% with specificity of 96% to 98%, with a positive predictive value (PPV) of 95% to 90%, and a negative predictive value (NPV) of 95%. Furthermore, our results agree with **Aggarwal *et al.*** [17] who showed that sensitivity of ultrasound was 83% and was 95% for specificity. **Satija *et al.*** [18] reported that ultrasound and colour Doppler remains the first primary modality for antenatal diagnosis of placenta accreta, with MRI reserved for cases where

ultrasound colour Doppler is inconclusive, which disagrees with our study due to use of MRI with ultrasound colour Doppler in prenatal diagnostic of placenta accreta. **Pilloni *et al.*** [19] confirmed that gray scale and colour Doppler ultrasound have good performance in the diagnosis of placental attachment disorders and that prenatal diagnosis improves maternal outcome with sensitivity of 89.7%, specificity of 99%, positive predictive value of 92.9% and negative predictive value of 98.6%. So, this agrees with our study. However, differentiation due to two reasons; the first was the use of transvaginal ultrasound with transabdominal ultrasound colour Doppler in diagnostic tools. The second was the location of placenta previa anterior or posterior position.

Regarding uterine artery Doppler value, our results showed the mean RI and PI indices of uterine arteries were statistically significantly lower in placenta accrete than in not accreta. This is in agreement with **Cho *et al.*** [20] who reported that the mean uterine artery PI was significantly lower in placenta accreta group compared to placenta previa group. Clinical records of all deliveries between April 2009 and March 2019 were retrospectively analyzed. All patients underwent uterine artery Doppler velocimetry to measure the mean resistive and pulsatility indices in the third trimester. This study found that the mean uterine artery PI was significantly lower in the placenta accreta group compared to previa alone (0.50 versus 0.56; p =.002). The diagnostic accuracy of placenta accreta can be potentially improved if uterine artery Doppler values and the history of cesarean delivery are combined [21]**.** According to **Zamanskaya *et al.*** [22], fifty pregnant women with normal placentation (Group 1), 50 women with placenta previa (Group 2) and 28 women with placenta accreta (Group 3) were examined in their study. The ultrasound examination included the traditional fetometry and an assessment of fetal anatomy and localization of the placenta. In addition, Doppler ultrasound was used to examine the blood flow in the uterine arteries as well as the umbilical artery and the middle cerebral artery of the fetus. The measurements were performed on the 20-22nd, 30-32nd and 35-36th weeks of gestation. The pulsatility index in the right uterine artery was significantly lower in patients with placenta accreta as compared to the two other groups. The data on fetoplacental hemodynamics indicated differences in the umbilical artery blood flow between women with placenta accreta, placenta previa and normal placental localization on the 20-22nd and 35-36th weeks of gestation. Along with the above findings in the uterine and fetoplacental hemodynamics, the parameters of blood flow in the fetal middle cerebral artery did not differ significantly between the three groups of women at any period of gestation. So the conditions of placenta accreta and placenta previa are associated with a decrease in the peripheral vascular resistance in both uterine arteries during all periods of gestation. This is supported by the lower values of the pulsatility index in these blood vessels in comparison with the value in patients with normal placental localization. **Mrazek-Pugh *et al.*** [23] reported that the accuracy of detection of placenta accreta by ultrasound and colour Doppler is increased. **Sharma *et al.*** [24] **agree** with this study. They reported that ultrasound and colour Doppler have important role in detection of morbidly-adherent placenta.

Debate remains over the optimal management of PA If the placenta fails to separate after delivery, leaving it in place and proceeding with either a hysterectomy or conservative management, rather than trying to separate it that is currently recommended by RCOG [25]. But, ACOG recommends planned, preterm caesarean section hysterectomy with the placenta left in situ as removal of a placenta accreta spectrum is associated with significant hemorrhagic morbidity [26].

Optimal antepartum and intrapartum management strategies for PA have not been fully cleared up yet. It is believed that an experienced multidisciplinary team should be prepared in a tertiary care to improve outcomes. Although hysterectomy has traditionally been advised in the management for suspected placental invasion abnormalities, conservative uterine preserving approaches have also been described to allow future fertility. Those approaches include leaving the placenta in situ after cesarean delivery, oversewing of the placental vascular bed, uterine compression sutures, bilateral uterine artery ligation and bilateral hypogastric artery ligation [27]**.** Several small-case series suggested that conservative management with uterine preservation is a safe and reasonable choice. However, successful management of PA is not guaranteed with conservative management [28]**.**

In our study, placenta was separated in 29 cases. Operators succeeded in conserving uterus in most cases but failed in 7 cases to manage hemorrhage and proceeded to hysterectomy. The most prevalent procedure was done to control bleeding from placental bed after placental separation was bilateral uterine artery ligation by a percent of 90%, uterine packing in 35% of cases, bilateral internal iliac artery ligation in 10% of cases and hemostatic sutures in placental bed in 25% of cases**.**

Antenatal diagnosis of PA is especially important and helps to reduce perinatal morbidity and mortality by allowing the clinicians to choose best time and place of delivery [29]. In general, U/S is considered the primary diagnostic tool for abnormal placentation because it is relatively inexpensive and widely available [25]**.**

CONCLUSION

Antenatal diagnosis of placental invasion by ultrasonography and colour Doppler was successful. The mean uterine artery velocemtric changes including mean resistive indices (RI) and mean pulsatility indices (PI) were significantly lower in the placenta accreta group compared to placenta previa group. However, the uterine artery Doppler values alone might be insufficient for differentiating placenta accreta from

placenta previa. The use of Gray scale ultrasound and colour flow Doppler is a good tool in diagnosis of placenta previa accreta.

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