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Original Article

Comparison Between Placenta Accreta Index and Tovbin Score as A Predictor of Placenta Accreta Spectrum Disorders (PASD)

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Abstract

Background : The incidence of Placenta Accreta Spectrum Disorders (PASD) in developed countries has reportedly increased 10-fold in the last 50 years. The significant increase was followed by an increase in the number of caesarean section from 12.5% to 23.5% in the last 10 years. Maternal morbidity related to PASD events reaches 7% in intraoperative and postoperative actions, while the morbidity reaches 60%. In cases of late diagnosis, maternal mortality with placenta accreta reaches 30%. Efforts to prevent maternal morbidity and mortality can be carried out by early detection at antenatal care visits. The Placenta Accreta Index (PAI) and Tovbin scoring systems based on the results of ultrasound examination can be used to screening for placenta accreta. The objectives of this study was to analyze the comparison of the accuracy of the PAI and Tovbin scoring systems in predicting the incidence of Placenta Accreta Spectrum Disorder (PASD).
Methods : The study used an analytic observational with a cross sectional design. Sampling was done by consecutive sampling method. There were 35 subjects who met the inclusion and exclusion criteria. PAI and Tovbin scoring were performed on each selected subject. The accuracy of the PAI and Tovbin scoring systems was confirmed by establishing a diagnosis based on PASD histopathology.
Results : The PAI scoring system in predicting PASD has a sensitivity value of 79.31%, a specificity of 83.33%, a positive predictive value (NDP) of 95.83%, a negative predictive value (NDN) of 45.45%, an accuracy of 80.00%. While the Tovbin scoring system obtained a sensitivity value of 86.21%, specificity of 83.33%, NDP of 96.15%, NDN of 55.56%, accuracy of 85.71 %.
Conclusion : In the comparison of scoring systems, it was found that the Tovbin scoring system has almost the same sensitivity and accuracy and the same specificity in predicting Placenta Accreta Spectrum Disorder (PASD).

Keywords : PAI, PASD, Placenta Accreta, Tovbin Score

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INTRODUCTION

Placenta Accreta is an abnormality or abnormal invasion of the placental tissue in the underlying layer, namely the uterine muscle.[1] The degree of abnormal placental implantation can be classified into three stages, placenta accreta, increta, and percreta. These three placental attachment disorders are now better known as Placenta Accreta Spectrum Disorders (PASD). The incidence of PASD in developed countries has increased 10-fold in the last 50 years, this is associated with an increase in the number of caesarean sections. A significant increase was followed by an increase in the rate of cesarean section from 12.5% to 23.5% in the last 10 years.[1–5] The incidence of placenta accreta in cases of placenta previa varied between 1.18%,9.3 and 10% of them with anterior placenta previa The mortality rate for placenta accreta reaches 7%, both intraoperatively and due to postoperative morbidity due to massive bleeding, infection, and organ damage, uterine damage,[4,5] and some report a morbidity rate of up to 60%.[5] Various efforts to prevent increased maternal mortality and morbidity from placenta accreta have been sufficiently studied, such as the use of ultrasound examination at antenatal visits to detect placenta accreta early. The American Journal of Obstetrics and Gynecology (AJOG) has issued a scoring system called the Placenta Accreta Index (PAI) score to predict whether a pregnant woman with placenta previa also suffers from placenta accreta.[6] Diagnostic test research in 2016, they issued a new scoring system that commonly referred to as the Tovbin Score. Scoring system that has been proposed by Tobvin showed sensitivity of 86–100%, the scoring system included the number of placental lacunae and obliteration of the uteroplacental demarcation.[7] The sensitivity and specificity of various ultrasound features for PASD change across the spectrum of placental invasion, and there is significant interobserver variability in the interpretation of placental invasion. As most ultrasound features are poorly defined.[8,9] At present, there is no consensus on a diagnostic standard for PAS. Combined evaluation of multiple indicators can objectively assess risk of PAS. The "Placenta Accreta Index", "ultrasound staging system for PAS", and "two-criteria system" have good diagnostic performance for PAS; however, sample selection (placenta previa or a history of cesarean section, or both), and the varying number, selection, and assignment of scoring indicators limit their clinical application.[10–15] Accurate prenatal diagnosis of PASD is challenging, especially in less severe cases, and diagnostic criteria remain under debate. The scoring system that is often used in RSUP Dr. Kariadi Semarang is the Placenta Accreta Index (PAI) score. However, the Tovbin scoring is still rarely used in Dr. Kariadi Semarang to predict the incidence of placenta accreta. The level of accuracy of both scores in predicting the incidence of placenta accreta at RSUP Dr. Kariadi Semarang has never been studied before. Therefore, establishing the correct diagnosis of placenta accreta by a specialist in Obstetrics and Gynecology is very important so that the referral process can be carried out in a timely manner. The objective of this study was to prospectively compare two diagnostic criteria between PAI and Tovbin score, evaluate its diagnostic value, and provide a practical approach to prenatal diagnosis of PASD.

METHODS

This research is an analytic observational study with a cross sectional design conducted at Dr Kariadi General Hospital, Semarang. The study began in August 2022 – April 2023. The research subjects were patients who met the inclusion and exclusion criteria. The inclusion criteria of this study included (1) Pregnant women with suspected placenta accreta, (2) Pregnant women with placenta previa, (3) Pregnant women with a history of previous CS, (4) Pregnant women with a history of uterine surgery, (5) Pregnant women with a previous history of placenta previa, (6) Pregnant women with third trimester pregnancies, (7) Obstetrical ultrasound (Voluson E8, GE Medical Systems, Zipf, Austria) examination and placenta accreta screening were performed 1 day before termination of pregnancy. While the exclusion criteria were patients who did not do antenatal ultrasound and refused to participate in the study. In total there were 35 research subjects who were obtained through the consecutive sampling method. All subjects who met the criteria underwent an ultrasound examination and then scored with PAI and Tovbin. To prevent any bias, the ultrasound examination was done by one person. Confirmation of the diagnosis was known through uterine and placental histopathology. An analysis was carried out regarding the values of sensitivity, specificity, NDP, NDN, and accuracy in each scoring system and then statistical analysis was carried out using the Chi-Square test. This research has received ethical clearance from the Health Research Ethics Commission (KEPK) Faculty of Medicine, Diponegoro University No. 1297/EC/KEPK-RSDK/2022.

RESULTS

Research subject in the study amounted to 35 people who met the inclusion and exclusion criteria. (Table 1) The characteristics of the study respondents were divided based on the patient's age, number of history of sectio caesarea, number of parity, gestational age, ante partum bleeding, length of stay, number of transfusions, preoperative Hb, postoperative Hb, baby's birth weight, APGAR score, amount of bleeding during surgery, postoperative ICU care, postpartum hemorrhage, hysterectomy, bladder injury, and intestinal injury.

TABLE 1
Subject Characteristics

Characteristics		Frequency (%)	Mean ± SD (Median)
Maternal Age	<20	0 (0)	
	20 – 35	24 (68.6)	
	>35	11 (31.4)	
Prior Sectio Caesarea	1x	15 (42.9)	
	2x	20 (57.1)	
Parity	2	13 (37.1)	
	>2	22 (62.9)	
Maternal Age	28 – 34	12 (34.3)	
	>34 – <37	20 (57.1)	
	>37	3 (8.6)	
Antenatal Bleeding	Yes	9 (25.7)	
	No	26 (74.3)	
Length of Stay	<5	5 (48.6)	
	5 – 7	15 (42.9)	
	> 7	3 (8.6)	
Hemoglobin level	Pre operative		10.65 ± 1.00 (8.9 – 13.0) 10.35 ± 1.47
	Post operative		(8.4 12.5)
Packed red cell transfusion	Not Transfusion	11 (31.4)	
	≥ 1	24 (68.6)	
Amount of bleeding	≤ 500 cc	13 (37.1)	1161.43 ± 1034.44 (967 – 1400)
	> 500 cc	22 (62.9)	
Post operative ICU	Yes	4 (11.4)	
	No	31 (88.6)	
Histerectomy	Yes	18 (51.4)	
	No	17 (48.6)	
Bladder Injury	Yes	7 (20.00)	
APGAR Score	*Vigorous baby*	33 (94.3)	
	Asphyxia	2 (6.7)	
Birth Weight (gram)	1500 – <2500	15 (42.9)	
	>2500	20 (57.1)	

All subjects received blood transfusions, both packed red cell (PRC), whole blood (WB), and fresh frozen plasma (FFP).

PAI and Tovbin scoring Scoring with PAI and Tovbin was carried out based on the results of the ultrasound examination of the subject. The mean Tovbin PAI score was 7.57 ± 2.02 (Table 3).

The scoring results were confirmed with the histopathological results of the PASD. The optimal cut off point value based on AUC (Area Under The Curve) in PAI scoring is 4.4. Scoring analysis using Tovbin with a cut off value of 7.5.

TABLE 2
PAI and Tovbin Score

Scoring Method	Mean ± SD
PAI	4.75 ± 1.22
Tovbin	8.09 ± 1.76

TABLE 3
***Cut off point* Scoring System**

Scoring methods		PASD (Histophatology)	
		PASD (+)	PASD (-)
PAI	≥4.4	23	1
	<4.4	6	5
Tovbin	≥7.5	25	1
	<7.5	4	5

TABLE 4
Diagnostic Test Analysis (PAI and Tovbin)

Parameter	Scoring Methods	
	PAI	Tovbin
Sensitivity (%)	79.31	86.21
Specificity (%)	83.33	83.33
Positive predictive value (%)	95.63	96.15
Negative predictive value (%)	45.45	55.56
Acc (%)	80	85.71
p	0.012*¥	0.002*¥
Relative risk (RR)	1.02 (3.03 – 4.51)	2.16 (1.04 – 4.51)

TABLE 5
PAI and Tovbin Scores Suitability Test

Scoring methods	Mean ± SD	Kappa
PAI	4.75 ± 1.22	
Tovbin	8.09 ± 1.22	0.742

Diagnostic Test Analysis (PAI and Tovbin)
Analysis of the diagnostic test with the PAI and Tovbin scoring systems showed that Tovbin had higher sensitivity, NDP, NDN and accuracy values compared to PAI while the specificity values for the two scores were the same ($p<0.05$).

Based on the results of the correlation and difference tests, it was statistically found that the use of PAI and Tovbin scoring had a significant relationship and difference ($p<0.05$). In addition to analysis related to diagnostic tests, analysis related to the suitability of the

results of use between scoring systems was also carried out (Table 5).

The results of the suitability test for the PAI and Tovbin scores indicated that the kappa index value was >0.6 so that it could be concluded that the suitability category between scoring systems was good.

DISCUSSION

The results of the study showed that the dominant PASD was at the age of 20–35 years. The correlation between age and PASD incidence was reported in a cohort study. The results of this study reported that the incidence of PASD increased at maternal age > 35 years.[16] These results were supported by epidemiological studies which reported an increased risk of PASD was found in women aged >35 years with other factors that could influence, including parity numbers, history of actions that could affect fertility, hormonal changes, and the site of implantation.[17] The differences found in the results of this study were associated with the average sample in the study being the productive age of mothers for pregnancy in Indonesia, namely ages 20–35 years.

All respondents in this study were multigravida. This is in accordance with previous studies which reported that 73.2% of patients with PASD were patients with multigravidas. Multigravida is associated with a history of previous pregnancies, especially a history of delivery by cesarean section and the condition of the uterus at the time.[18] Patients with a history of cesarean section have a 2.2x fold risk of experiencing PASD in subsequent pregnancies.[19] The increased risk rate increases in proportion to the frequency of previous cesarean sections. The risk of pregnancy with a history of cesarean section ≥2x can increase to 17x.[20] In conditions of pregnancy with surgical scars, both from a history of cesarean sections and other operative actions on the uterus, it causes implantation of the blastocyst into the hysterotomy scar and will cause a PASD condition.[21]

The elective caesarean section procedure is more at risk of experiencing PASD compared to the emergency caesarean section procedure. This is hypothesized through two mechanisms including differences in position technique, length, and healing time of incision wounds and better immune conditions after the onset of labor. The condition of the uterus in an emergency caesarean section tends to have adequate contractions so that the incision wound becomes shorter, damage to the endometrium becomes minimal and makes the tissue more potential for the healing period.[17]

The gestational age at the time of Caesarean section for the respondents in this study ranged from >34 – <37 weeks by 57.1% and >37 weeks by 8.6%. This is in line with a study in Vietnam 2022 where elective caesarean section was mostly performed at >37 weeks of gestation.

Assessment of Hb levels before and after surgery was carried out for all respondents. Most of the respondents (68.6%) needed PRC blood transfusions to overcome blood loss during the procedure. As many as 51.4% of respondents underwent hysterectomy and 11.4% were found to have complications from bladder injuries. The range of hospitalization for respondents was 2–13 days and 11.4% of them needed treatment in an intensive room.

The neonatal outcomes of this study were known to be 94.3% of babies born healthy with 42.9% of babies born with normal weight and 57.1% of babies born weighing ≥2500 grams. This is consistent with research on the neonatal outcomes of PASD patients where 78.5% of babies were born with a weight ≥2500 grams. Previous research in 2020 reported on patient outcomes after hysterectomy and conservative surgery for PASD indications. The determination of treatment is considered based on the results of the PAI score assessment and a definitive diagnosis is made intraoperatively. The use of the PAI score was significantly associated with diagnosing PASD ($p<0.001$).[22]

Based on the results of the PASD diagnostic test with the PAI scoring system in this study, the sensitivity value was 79.31%, specificity 83.33%, NDP 95.83%, NDN 45.45%, accuracy 80.00% with a cut-off value of 4.4. The PAI score scoring system includes a history of CS ≥2x, lacunae assessment using the Finberg William classification, myometrial thickness, placenta previa, and bridging vessels.[23] In the PAI scoring system, the degree of lacunae provides the maximum score weight that can change the final score. The greater the size and irregularity of the lacuna, the greater the risk of PASD. The use of Doppler images can improve the accuracy of the diagnosis because of its ability to identify a more accurate depth of placental invasion.[24]

Another predictor variable that influences the incidence of PASD is myometrial thickness. Myometrial thickness is an important predictor of PASD. A diagnostic study by Verma *et al* reported that the myometrial thickness variable had a sensitivity of 85.9%, a specificity of 71.4%, with a cut-off value of 0.88 mm in predicting the incidence of PASD.[25] The cut-off in this study was not much different from the PAI scoring system, where myometrial thickness ≤ 1 mm is given the highest score weight. The reduced myometrial thickness in PASD cases may be due to vascular abnormalities and placental invasion. Thus, variable myometrial thickness can be considered as a marker of abnormalities and functional abnormalities of the placenta.[26]

Diagnostic study of the PAI scoring system in predicting the incidence of PASD in 177 cases of placenta previa, 142 of whom were diagnosed with PASD. The sensitivity of using PAI reaches 75%, specificity 83% with a cut off value of 4.6.[23] The results of these studies with this study have a difference of approximately 1% in the

diagnostic component and 0.2 in the cut off. This shows that there is consistency in the use of the PAI scoring system.

Another scoring system was created to predict PASD morbidity, namely the Tovbin scoring. In our study, the results showed that the Tovbin score had an AUC value of 93.1% and the cut-off value of the Tovbin score based on placenta accreta was 7.5. From the results of the diagnostic test in this study, the sensitivity value was 86.21%, the specificity value was 83.33%, the positive predictive value was 96.15%, the negative predictive value was 55.56% and the accuracy value was 85.71%. The differences in the Tovbin and PAI scoring systems are in the description and assessment of the lacuna, the location of the placenta, the parameter of obliteration of the uretroplacental demarcation (loss of clear zone), and the use of Doppler in assessing the vascularization of the placenta urinary bladder (bridging vessel). Based on the components assessed, the Tovbin scoring system is considered more complete and simpler than PAI. The Tovbin scoring system assesses lacuna by describing the weight of the score based on size and number, while the PAI scoring system uses the Finberg William grading system.

Parameter of demarcation obliteration in the uteroplacental (loss of clear zone) is considered effective in predicting PASD. The utility for the parameter of the absence of demarcation at the uteroplacental boundary is based on the fact that trophoblastic tissue invasion of the myometrium and the absence of decidua basalis in invasive placentation can progressively lead to reduction of myometrial thickness and loss of space between the myometrium and placenta.

Another scoring parameter in Tovbin that is not included in the PAI is the assessment of lacunae blood flow using Doppler. Although in PAI scoring an assessment of bridging vessels is carried out, bridging vessels can only appear if there is a large amount of neovascularization.[27] The parameters in Tovbin assess in more detail regarding blood flow in the lacunae and hypervascularization of the placenta to the bladder.

The Tovbin scoring system began to be developed in 2016. The Tovbin scoring system is considered to have a high accuracy value in predicting PASD case. Research on the diagnostic test of the Tovbin scoring system was carried out involving 258 pregnant women with placental implantation abnormalities. The results of the study reported a sensitivity value of 69.6% and a specificity of 98.7%.[28]

Based on the results of a comparison using the Tovbin and PAI scoring systems in this study, it was found that the Tovbin scoring results had a sensitivity value that was almost as good as PAI while the specificity values were the same. From the results of this study, it was found that the tovbin score had a better accuracy value than the PAI score in predicting Placenta Accreta Spectrum Disorders (PASD). Based on the results of the kappa index value in the suitability test, it was concluded that the PAI and Tovbin scoring systems had good compatibility.

Results have proven that Tovbin significantly better scoring system for early detection of PASD. Its implementation should be done carefully by skillfull obstetric and gynecologic specialist during antenatal care in order to maximize the outcome and prevent bias existed due to ultrasound operator skill.

CONCLUSION

The Tovbin score has almost the same sensitivity and accuracy values and the same specificity value in predicting PASD compared to the PAI scoring system. It can be concluded that the two scoring systems have a good value fit. Tovbin score can be used by obstetricians and gynecology specialists in referral hospitals as an alternative diagnostic tool in predicting PASD events besides PAI scores, especially in patients with a history of 1x cesarean section with suspicion of PASD. We hope that future researh able to develop scoring system for early detection of PASD with better sensitivity and specificity score, hence adaptable for various diagnosis challenge condition of PASD.

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Conflict of Interest
The authors certify that they have no competing financial interests or personal relationships that could influence the work reported in this paper.

Research Ethics
The research was approved by the Health Research Ethics Committee, Faculty of Medicine, Diponegoro University Dr. Kariadi Semarang.

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