Prediction of Postoperative Major Complications in Pancreaticoduodenectomy -a Prospective Comparative Analysis of Braga and WHipple-ABACUS Scores

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ABSTRACT

Background

Major complications following pancreaticoduodenectomy have a severely deleterious effect on postoperative course, rather than just occurrence of pancreatic fistula. Surgical risk stratification with Braga and WHipple-ABACUS have been proposed and validated.

Objective

The study aimed at comparing the Braga and WHipple-ABACUS scores for prediction of major complications following pancreaticoduodenectomies.

Method

This was a prospective observational study at the Tribhuvan University Teaching Hospital from February 2018 to April 2019. After ethical approval, all consecutive 41 patients who underwent pancreaticoduodenectomies were included. Each patient was graded in Braga and WHipple-ABACUS scores. Perioperative events occurring over 30 days were graded as per Clavien -Dindo complications for pancreatic surgery. The predictive value of the scores were assessed using a receiver operating characteristic curve analysis. The categorical data were compared using the Pearson χ^2 test or Fisher's exact test.

Result

Over period of 14 months, total of 41 patients (M:F=2.15:1) with median age of 58 years (range, 21-86) underwent pancreatoduodenectomy. The mean scores were Braga (4.6±3.1) and WHipple-ABACUS (1.8±1.6). Major complications over 30 days were developed in 11 patients with five mortality. There were significant differences in mean values of Braga score (7.0±3.4 vs 3.7±2.6, p-value=0.02) and WHipple-ABACUS score (3.2±1.8 vs 1.3±1.3, p-value=0.01) in patients with major complications to those without respectively. The area under curves for Braga and WHipple-ABACUS scores were 0.800 and 0.779 respectively.

Conclusion

Both WHipple-ABACUS and Braga scores are easy to calculate and predict the development of major complications significantly in patients undergoing pancreatoduodenectomy.

KEY WORDS

Braga score, Pancreaticoduodenectomy, Post-operative pancreatic fistula, WHipple-ABACUS score

INTRODUCTION

Pancreaticoduodenectomy (PD) is among the most complex visceral procedures. Though mortality rates have been reduced to <5%, perioperative morbidity rates remain high, at up to 30-50%.[1-4] Pancreatic fistulas, the most analyzed complication in literature, are less compromising for the patient and mostly do not necessitate intervention whereas others can severely impair postoperative course.[5,6] Postoperative complications over 30 days have been graded according to Clavien -Dindo classification validated in pancreatic surgery.[3] Major complications (grade III and above) range between 16.7 to 33% in different series.[7-9] These complications result in longer hospital/ intensive stay and increase in costs.[10] A simple score able to identify patients with increased risk of major complications rather than pancreatic fistula alone is needed.

Braga score is based on two indicators of pancreatic morphology, one indicator of surgery complexity, and one indicator of patient status.[7] The predictive score ranges between 0 to 15 with c-statistic index of 0.743 with an increasing probability to develop major complications from 7 to 36% in four risk groups.[7] "WHipple-ABACUS is simple and completely preoperative tool; ranges between 0 to 6.[11] This score validate mortality with c-statistic index 0.71 with incremental score.[11] Identification of high-risk patients could help the surgeon to adopt perioperative strategies tailored on individual basis and to provide proper prognostic information. There is sparse of published literature in comparing various scoring system in prospective studies.

The aim of this prospective study was to compare accuracy of Braga score and WHipple-ABACUS scores in predicting postoperative major complications in pancreaticoduodenectomies.

METHODS

This was a predominantly quantitative prospective observational study conducted at the Department of GI and General Surgery, Tribhuvan University Teaching Hospital (TUTH), Kathmandu, Nepal. Nonprobability (convenience) sampling method was utilized. Sample size was calculated by using formula [$n=z^2p(1-p)/e^2$]. Considering prevalence of major complications of 30.6% and with 95% of confidence interval (CI), and 10% drop out, calculated sample size of 41 were required.[8] All consecutive patients who underwent PD from February 2018 to April 2019 were included in the study. Patients with age ≤ 16 years or patients who decline to participate in the study and lost to follow up were excluded. After ethical approval of the study from Institutional Review Board (IRB), Institute of Medicine patients were enrolled [IRB-298(6-11-E)2/074/075]. Well informed written consents were taken from the patients or his/her legal guardians before enrolling into the study and every patient had the right to withdraw from the study, at any point of time, if he/she wished to do so. No additional harm or financial burden in regards to drugs or investigations (besides institutional practice) were given to the participants. All data were kept on password protected computers accessible to principal investigator only and would made available on request in accordance with the IRB. Confidentiality and anonymity of all patients were maintained.

Proforma was used for data collection and data were entered in Statistical Package for the Social Sciences (SPSS) for Windows version 20. Collected data were analyzed using SPSS version 20.0 and Microsoft excel 2016. Qualitative data were expressed in proportion and percentage; and quantitative data as mean ± SD or median (range). Descriptive statistics were expressed in tables, graphs and charts, whenever applicable. Differences between the 2 groups were compared using the student T-test as parametric test and Mann–Whitney U-test as nonparametric test. Differences between groups of categorical variables were assessed using the Pearson's Chi-squared (χ^2) test or the Fisher's exact test based on expected frequencies. The predictive value of the Braga score and WHipple-ABACUS scores in predicting postoperative major complications in PD were assessed using a receiver operating characteristic (ROC) curve analysis. The area under the curve (AUC) was calculated to determine the discrimination ability of all the scores. As a general convention, an AUC between 0.7 and 0.8 is considered good acceptable discrimination, an AUC between 0.8 and 0.9 denotes excellent discrimination, and an AUC greater than 0.9 outstanding discrimination. The maximum Youden index was used to determine the best cut-off point of scores for predicting major complications. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of each score were calculated. The p-value less than 0.05 was taken as statistically significant.

Patients were admitted in the surgery ward at least one day prior to PD. Pancreaticoduodenectomies were performed as per indications of surgery in standard practice. All preoperative and intraoperative variables as per study design were recorded in proforma.

Pancreaticoduodenectomies (either stomach sparing pancreaticoduodenectomy (SSPD) or classical) were performed in standard steps of resection and reconstruction. Pancreatojejunostomy (PJ) was carried out by dunking method with 3-0 polypropylene suture in all patients in this study. Following PJ anastomosis, single layer duct-mucosa hepaticojejunostomy (HJ) was performed. An antecolic gastrojejunostomy followed by Braun's jejunojejunostomy was also constructed. Two abdominal drains of 20 Fr size were placed close to PJ (left sided posterior to PJ) and HJ (right sided in Morrison's pouch). Patients were kept nil per oral from mid-night before surgery. Prophylactic antibiotic injection ceftriaxone (1 gm) was given intravenously 30 minutes before incision. Injection octreotide (100 µg) was

given intravenously just before pancreatic transection and continued postoperatively at the frequency of eight hours for minimum of three days. Postoperatively, maintenance IV fluid was given along with analgesics (intrathecal morphine, fentanyl, paracetamol), pantoprazole, antibiotic (usually ceftriaxone or piperacillin-tazobactam or higher based on preoperative culture reports or in presence of clinical deterioration). Further medications changed on the basis of subsequent course of the patients. All patients were managed in the postoperative ward for three to five days then transferred to the ward once orally started, mobilization done, and patients became stable hemodynamically. Drain amylase was checked on third postoperative day (POD) or subsequent days depending on further course. Nasogastric tube was removed and sips started on either second or third postoperative if there was no blood or any complications. Right drain was removed usually on third to fifth POD and left drain on fifth to seventh POD with the exclusion of postoperative pancreatic fistula (POPF), post pancreatic hemorrhage (PPH), biliary or intestinal fistula and serous content of drain. Any complication if occurred were managed as per institutional practice. Patients were discharged after meeting the following criteria: absence of fever (<37.5°C) for more than 48 hours, good pain control with oral analgesics, adequate oral food intake and mobilization, after removal of drains or after managing any complications if occurred and acceptance of discharge by the patient. Patients were followed up for 30 days postoperatively and any significant events were noted. Readmission within 30 days after discharge were also recorded.

Each patient was graded in each scoring system (Braga & WHipple-ABACUS) as defined in table 1. Braga score was calculated based on American Society of Anesthesiologists (ASA) score of patients as determined by anesthesiologist on day before surgery, and three intraoperative parameters like pancreatic texture, main pancreatic duct (MPD) diameter and intraoperative blood loss. Pancreatic texture (soft or firm/hard) and duct dimeter were determined by operating consultant surgeon after pancreatic transection. Similarly, intraoperative blood loss was calculated by considering the suction volume, use of fluid for irrigation, wash intraoperatively, peritoneal fluid on opening abdomen (ascites) and number of soaked gauze and sponges. Similarly, WHipple-ABACUS score was calculated based on age of >62 years, presence of hypertension with medication, history of cardiac surgery, bleeding disorder disseminated cancer, use of steroids, preoperative systemic inflammatory response syndrome (SIRS) criteria on day before surgery; and albumin of <3.5 gm/dL.

All the perioperative events over 30 days were collected in proforma and graded as per Clavien -Dindo complications for pancreatic surgery. Post-operative complications with Clavien -Dindo class ≥ III and above were defined as major complications. Death occurring within the same hospital admission or within 30 days of surgery was considered as perioperative mortality. Postoperative organ failure was defined as the need for re-intubation, hemodialysis, and/or inotropic agents >24 hours for respiratory, renal, or cardiac insufficiency, respectively. Other procedure specific complications like POPF, PPH and delayed gastric emptying (DGE) were defined and graded as per International study group for pancreatic surgery (ISGPS). International study group for pancreatic fistula (ISGPF) in 2016 defines clinically relevant postoperative pancreatic fistula (CR-POPF) as a drain output of any measurable volume of fluid with amylase level greater than three times the upper institutional normal serum amylase level, associated with a clinically relevant development/condition related directly to the POPF.[12] POPF has been classified into biochemical leak, grade B POPF, and grade C POPF. All clinically relevant conditions owing to organ failure, reoperation, and death are labelled as grade C POPF.[12] Post pancreatectomy hemorrhage (PPH) is defined as blood loss from drain or nasogastric tube, transfusion of ≥3 units of packed red blood cells, or need for invasive treatment.[13] Similarly delayed gastric emptying (DGE) has been defined as inability to return to a standard diet by the end of the first postoperative week or prolonged (≥4 days) nasogastric intubation.[14]

Table 1. Definition of Scoring systems -Braga and WHipple-ABACUS

Braga Score		WHipple-ABACUS Score	
Pancreatic texture		Hypertension With medication	1
Hard	0	History of cardiac surgery	1
Soft	4	Age > 62	1
Pancreatic duct diameter		Bleeding disorder	2
>3 mm	0	Albumin <3.5 g/dL	1
≤3 mm	1	Cancer (disseminated)	2
Operative Blood Loss		Use of steroids	2
< 700 mL	0	Preoperative SIRS criteria met	2
≥ 700 mL	4		
ASA Score			
I	0		
II	2		
III	6		
Total: Braga	**0-15**	**WHipple-ABACUS**	**0-12**

ASA- American Society of Anesthesiologists, SIRS- Systemic Inflammatory Response Syndrome

RESULTS

Over period of 14 months, a total of 41 consecutive pancreaticoduodenectomies were performed. The demographic and clinical characteristics of the patients were shown in table 2. Ampullary adenocarcinoma was the most common indication (18, 43.9%) of PD in this study followed

Table 2. Demographic and clinical characteristics of the patients

Patient Characteristics	Values (n =41)
Age (years)	58 (21-86)
Gender - Male	28 (68%)
BMI (kg/m^2)	20.1 ± 2.4
Duration of symptoms (days)	60 (14 – 540)
ASA	
ASA I	19 (46.3%)
ASA II	19 (46.3%)
ASA III	3 (7.3%)
SIRS criteria met (≥ 2 out of 4)	10 (24.4%)
Hypoalbuminemia (< 3.5 g/dL)	22 (53.7%)
Cholangitis/ Preoperative Biliary Drainage	
PTBD	7 (17.1%)
ERCP Stenting	6 (14.6%)
Disease origin - Pancreatic	8 (19.5%)
Pathology - Malignant	38 (92.7%)

Categorical data expressed in no (%), & continuous data in mean ± SD or median (range); BMI – Body mass index, ASA – American Society of Anesthesiologists, SIRS – Systemic Inflammatory Response Syndrome, PTBD – Percutaneous Transhepatic Biliary Drainage, ERCP – Endoscopic Retrograde Cholangiopancreatography

by pancreatic ductal adenocarcinoma (PDAC) in six cases (14.6%). Besides these, other less frequent indications were distal cholangiocarcinoma (4), SPN of head of pancreas (2), duodenal (D2) adenocarcinoma (2), gastric antro-pyloric adenocarcinoma involving pancreatic head (2), gall bladder adenocarcinoma involving up to distal common bile duct and duodenum (1), hepatic flexure adenocarcinoma invading duodenum (1), duodenal (D3) adenocarcinoma (1), duodenal (D2-ampullary) gastrointestinal stromal tumor (GIST) (1). Remaining three cases were done for preoperative suspected malignancy which turn out to be benign on postoperative histopathological examination; the diagnosis was one of each of adenomyoma of ampulla, adenoma of ampulla and duodenal intraepithelial neoplasm. Extended PD was performed in eight patients including vascular reconstruction, right hemicolectomy, extended cholecystectomy with right hemicolectomy, and D2 Distal gastrectomy in addition to PD. All patients underwent dunking type of pancreatojejunostomy anastomosis. Various intraoperative details were recorded in table 3.

The mean WHipple-ABACUS score was 1.83±1.62 (range, 0-6) while mean Braga score was 4.56±3.12 (range, 0-14); and both scores had good correlation with Spearman's rho correlation coefficient of 0.430 (p=0.005).

Patients postoperative events were recorded in table 4. All perioperative events over 30 days were categorized as per Clavien- Dindo classification for pancreatic surgery and complications with grade III and above were graded as major complications (Fig. 1). Eleven (26.8%) patients develop major complications while five (12.2%) patients had mortality over 30 days (grade V). Biochemical leak was present in 15 cases (37.5%). Clinically relevant POPF were present in 20% cases (grade B-6 and grade C-2). POPF related mortality occurred in two patients. Out of PPH, four cases were late onset, severe, extraluminal type (Grade C), two cases had early, severe, intraluminal type (grade B) and one case had early mild (grade A). Grade A and grade B DGE were seen in 10% of patients each while grade C DGE was seen in one patient. No patients had biliary fistula while intrabdominal collections were seen in two cases.

Table 3. Intraoperative Details

Characteristics	Values (n= 41)
PD types	
SSPD	26 (63.4%)
Classical	13 (31.7%)
With D2 distal gastrectomy	2 (4.9%)
Pancreatic Texture	
Soft	26 (63.4%)
Firm/ Hard	15 (36.6%)
MPD Diameter (mm)	4.0 (range, 1-11)
Intraoperative blood loss (ml)	387.8 ± 160.0
Operation duration (min)	357.6 ± 100.9

Categorical data expressed in no (%), and continuous data in mean ± SD or median (range); PD-Pancreaticoduodenectomy, SSPD – Stomach sparing PD, SMA – Superior mesenteric artery, MPD – Main pancreatic duct.

Table 4. Postoperative issues

Postoperative Issues	Values (n=41)
Complications	24 (58.5%)
Surgical site infection (SSI)	
Superficial	12 (29.3%)
Deep	3 (7.3%)
Intraabdominal collection	2 (4.8%)
Wound dehiscence	1 (2.4%)
Pneumonia/ Chest infection	8 (19.5%)
Cardiac arrhythmia	2 (4.8%)
Neurological dysfunction (Seizure)	1 (2.4%)
CR-POPF#	8 (20%)
Bleeding (PPH)	7 (17.1%)
DGE#	9 (22.5%)
Major Complications (Clavien-Dindo III and above) over 30 days	11 (26.8%)
Mortality	5 (12.2%)
Re-exploration	1 (2.4%)
Hospital stay (days)	10 (7-29)
Readmission	5 (12.2%)

Categorical data expressed in no (%), and continuous data in mean ± SD or median (range). #one re-exploration case excluded; CR-POPF – Clinically relevant postoperative pancreatic fistula, PPH – Post pancreatic hemorrhage, DGE – Delayed gastric emptying.

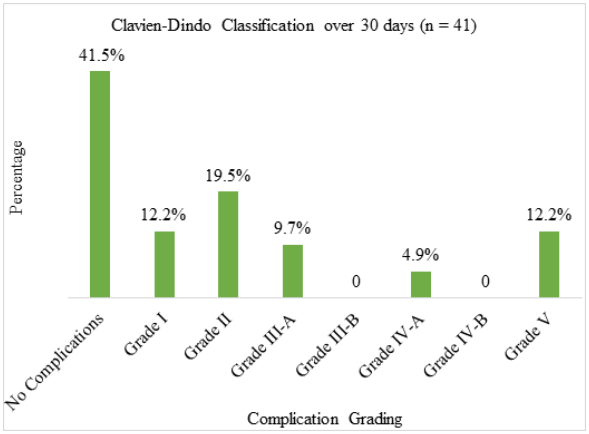

Figure 1. Clavien-Dindo Classification over 30 days

Prediction of postoperative major complications over 30 days

Major complications group had significantly (p-value < 0.001) lower mean BMI, presence of SIRS, lower albumin level as compared to no complication group. However, other demographic variables, preoperative biliary drainage, total bilirubin, pathological origin and malignant nature had no significant differences. Among various intraoperative and postoperative variables, there were no significant differences in pancreatic texture, MPD diameter, extended PD, PD with vascular resection, duration of surgery, and intraoperative blood loss between the group of patients with and without major complications. Presence of PPH had significant difference (p-value <0.001) in between development of major complications and no major complications. However, presence of CR-POPF and DGE had not statistically significant difference between the groups of with or without major complications.

Both Braga score and WHipple-ABACUS Score had significantly higher mean±SD values in patients with major complications as shown in table 5.

Table 5. Comparison between scores and major complications over 30 days

Score	Major Complications	N	Mean ± S. D	p
Braga score	No major complications	30	3.7 ± 2.6	
	Major Complications	11	7.0 ± 3.4	0.02
WHipple-ABACUS score	No major complications	30	1.3 ± 1.3	
	Major complications	11	3.2 ± 1.8	0.01

Continuous data in mean ± SD

Predicting ability of Scoring system

An AUC of 1 corresponds with a perfect prediction and an AUC of 0.5 with no discriminatory power at all. The area under ROC curve for Braga, and WHipple-ABACUS scores for prediction of major complications over 30 days were 0.779 (95% CI; 0.616 - 0.942; p=0.007), and 0.800 (95% CI; 0.632 - 0.968; p=0.004) respectively suggesting a good discrimination ability of both scores in predicting

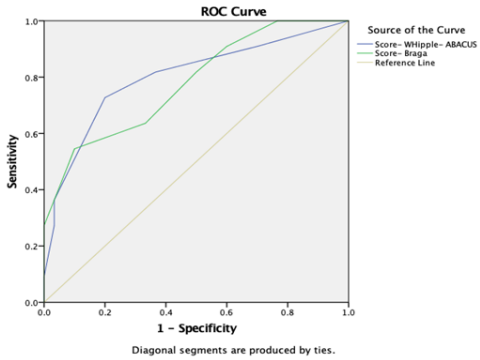

Figure 2. Receiver-Operating Characteristic (ROC) Curve for Major complications over 30 days

major complications over 30 days as shown in figure 2. In other words, both scoring systems may predict major complications over 30 days significantly. The AUC for mortality prediction was 0.800 (95% CI; 0.541-1.000; p=0.031), and 0.894 (95% CI; 0.788-1.000; p=0.005) for Braga and WHipple-ABACUS scores respectively, suggesting an excellent discrimination ability of both scoring systems in predicting mortality. Similarly, the AUC for Braga and WHipple-ABACUS scores for predicting CR-POPF was 0.832 (95% CI; 0.695-0.970; p =0.004), and 0.639 (95% CI; 0.387-0.890; p=0.230) respectively. The prediction of CR-POPF by Braga score was better as compared to WHipple-ABACUS. We also calculated the optimal cut-off of each score based on Youden index calculated from ROC curve. The cut-off value for Braga Score for major complications over 30 days was six (6) and that for WHipple-ABACUS score was two (2). The sensitivity, specificity, PPV, NPV and accuracy of Braga scores for predicting major complications were 54.5%, 90%, 66.7%, 84.4% and 80.5% respectively while that for WHipple-ABACUS score were 72.7%, 80%, 57.1%, 88.9% and 78% respectively. Both Braga score and WHipple-ABACUS had predicted major complications, mortality, and CR-POPF significantly.

DISCUSSION

A combination of careful patient selection, meticulous technique, and standardized perioperative care is an effective strategy to minimize morbidity and mortality following PD. Risk scores have been analyzed to identify patients at high risk for complications. A total of 41 PD cases over 14 months at TUTH were analyzed with prediction of major complications by Braga and WHipple-ABACUS scores. We had 41.5% of population aged > 62 years. Obstructive jaundice was the most common presenting symptom (61%) followed by anorexia/ weight loss. Preoperative biliary drainage was done in 13 cases (31.7%); all with preoperative cholangitis. PD was performed for mainly malignant disease in 92.7% and disease origin of pancreas in 19.5%. Though carcinoma head of pancreas was considered most common indication of PD worldwide, ampullary adenocarcinoma was the most common (43.9%) in this study followed by pancreatic neoplasm (19.5%) which includes PDAC (14.6%)

and SPN of head of pancreas (4.9%).[15] Late presentation of pancreatic malignancies, being unresectable at time of presentation, might be cause of lower incidence in this series.[15,16] Contrary to which, ampullary adenocarcinoma presents earlier due to early development of symptoms in form of obstructive jaundice.[16] Therefore, most of ampullary adenocarcinoma were able to undergo curative PD as compared to PDAC. Fifteen cases (36.6%) in this study had MPD of up to 3 mm diameter and 63.4% had soft pancreatic texture on intraoperative assessment by the surgeon.

Even with improved perioperative care and better and advanced surgical skills, postoperative complications ranges from 30 to 60% out of which major complications account for 15 to 40% in various reported series.[6,15] Major complications with Clavien- Dindo grade III and above were developed in 11 cases (26.8%) in this study. Notably mortality rate over 30 days was 12.2%. Similarly, serious complications (IV-V) accounting organ failure and death were seen in 20.1%. Among five mortalities, two were POPF related and three were not related to POPF. Well the overall complication rate along with major complications are comparable to many published literature.[7] Considering major complications (III-V), our study had 26.8% which is higher than Braga original study of 16.7% while lower than 31% in Braga's score validation study by Joliat et al. and Gleeson et al.[7,8,11] But 30 days-mortality rate in our study were incredibly high.[7,8,11] Though surgical site infection (15) are common complications, chest infection/ pneumonia (8) and cardiac issues (2) are more bothersome ones in regards of further clinical outcomes. So, management of cardiopulmonary complications should be of priority besides the most dreadful and discussed CR-POPF. The POPF rate has been reported from 12 to 32.7% in the various studies.[17-19] In our study, POPF rate was 20% (Grade B- 6 and grade C-2) which is lower than the study done by Kajiwara et al. in Japan.[20] POPF related mortality occurred in two patients. Similarly, out of 11 major complications, CR-POPF was present in 25% (4/10). Also, the cornerstone to the management of POPF is every effort should be opted to prevent progression of grade B to grade C. So, with limiting the grade C POPF will minimize the fatal outcomes. DGE has been reported from 19 to 57% in the studies.[14,21] In our study, DGE were observed in 9/40 (22.5%) patients which is lower to other study.[20] PPH is an uncommon complication after PD but is one of the major causes of peri-operative mortality.[22] The incidence of PPH has been reported from 4 to 16% and the mortality is as high as 11 to 54%.[22-24] In our study, PPH were developed in 7/41 (17.1%) which included four cases (late onset, severe, extraluminal type -grade C), two cases (early, severe, intraluminal type -grade B) and one case (early mild -grade A). Patients who developed late and severe PPH were managed with embolization of aneurysm from branch of splenic artery, out of which mortality occurred in one patient who had concomitant grade C POPF. One case of early and severe PPH was reexplored on second POD and succumbed to death on third POD. However, other cases were managed successfully. Surprisingly the incidence of severe PPH was high as compared to recent literature.[25,26]

We had evaluated various factors for development of major complications. Presence of SIRS and hypoalbuminemia are obvious predictors of complications as found in this study too.[11,27,28] Though soft pancreas, smaller duct, blood loss, extended PD and PD with vascular resection are considered significant predictors of complications, but we did not find.[29,30] We calculated WHipple-ABACUS score preoperatively on day before surgery while Braga score after completion of surgery based on predefined variables. In this study, mean WHipple-ABACUS score was 1.83 ± 1.62 (range, 0-6) while mean Braga score was 4.56 ± 3.12 (range, 0-14). There was good correlation between these two scores. Comparison between major complications group and no major complications group showed significant difference in WHipple-ABACUS score (3.18±1.78 vs 1.33±1.27, p-value =0.01) and Braga score (7.00±3.35 vs 3.67±2.55, p-value =0.02). Discrimination ability of the scores in predicting major complications, we found AUC of 0.800 for WHipple-ABACUS score (95% CI; 0.632 - 0.968; p=0.004) and 0.779 for Braga score (95% CI; 0.616 -0.942; p=0.007). So, both scores are good predictors of developing major complications in which WHipple-ABACUS score predicted better than Braga score. Comparing the discrimination ability of major complication by Braga score in our study, c-statistic index was 0.779 (95% CI; 0.616 - 0.942; p=0.007) which is better than 0.743 (95% CI, 0.657 - 0.829, p<0.001) of original Braga study7 but poorer than 0.992 (95% CI, 0.983-1, p<0.001) Braga validation study by Joliat et al.[8] Though discrimination ability of major complications were not defined using WHipple-ABACUS score, Gleesen et al. conducted the predictability by significant factors and found AUC of 0.60 while using this score we found AUC of 0.800 (95% CI; 0.632 - 0.968; p= 0.004).[11] Similarly, prediction ability for mortality over 30 days also showed WHipple-ABACUS score (AUC -0.894; p=0.005) much better than Braga score AUC -0.800; p= 0.031). Looking into literature, we found that our study had better predictability for mortality of AUC 0.894 (p-0.005) than study by Gleesen et al. with AUC of 0.71 (p<0.01).[11] Though Braga score predicted mortality too in our study, we did not find any study for mortality prediction by Braga score.[7] Contrary to this, CR-POPF prediction ability was excellent by Braga score (AUC 0.832; p=0.004) and poor by WHipple-ABACUS score (AUC -0.639, p-0.230). This sort of discriminating ability could be explained due to the fact that WHipple-ABACUS score considers all comorbidities, physiological parameters of patient, so development of major complications along with mortality but not procedure specific complications like POPF. But Braga score considers procedure specific parameters like gland morphology, duct diameter, blood loss along with premorbid ASA status, so development of POPF could have been better predicted

along other major complications. However, both scores did not predict of PPH and DGE.

Considering the best cut-off of > 2 for WHipple-ABACUS and > 6 for Braga score, we found WHipple-ABACUS score as more sensitive 72.7% vs 54.5% than Braga score in predicting major complications while Braga score was more specific 90% vs 80% as compared to WHipple-ABACUS. Also, both scores had better NPV as compared to PPV. Again, predicting the complications with the above-mentioned cut-off, both WHipple-ABACUS score of >2 and Braga score of >6 predicted major complications, mortality and CR-POPF significantly but not PPH and DGE. Comparing each procedure specific complication in between the group, presence of PPH were significant in major complications group ($p<0.001$) while presence of CR-POPF and DGE were not.

Braga score can be calculated intraoperatively easily, simple tool to calculate and we had validated the prediction of major complications along with mortality and CR-POPF in this study. Owing to the fact that WHipple-ABACUS is the first simple and validated score to use preoperative factors alone to estimate the probability of 30-day mortality after PD, we had validated the score in our setup for prediction of major complications along with mortality over 30 days well. So, identification of high-risk patients could help the surgeon and team to adopt intraoperative and postoperative strategies tailored on individual basis and to provide proper prognostic information to the patient. Strength of these scoring systems is the prediction of surgical risk targeted on severity of complications, regardless of their type. This will be also useful for the informed consent of patients, as they may better understand the associated risk of the procedure.

CONCLUSION

Both WHipple-ABACUS score and Braga score are easy to calculate and predict the development of major complications over 30 days significantly in patients undergoing pancreatoduodenectomy. WHipple-ABACUS score predicted mortality better than Braga score while prediction of clinically relevant POPF is better with Braga score. Further multicentric studies are required to validate this finding.

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