

Surgical Apgar Score, Predictor of Post-Emergency Abdominal Surgery Outcome

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Abstract

The surgical team always tries to provide consistently low incidence of major complications for patient undergoing any operation. Recognizing patients at high risk of developing a complication will contribute substantially to quality of operation and of cost reduction in surgery. In operating room, surgical apgar score (SAS) has helped surgeons for objective assessment of the operative course for postoperative prognostication instead of their "gut-feeling". Here we prospectively evaluated postoperative complications according to SAS. This was a hospital based, single centre longitudinal prospective observational study from October 2014 to March 2015 including 66 patients. There was significant association between type of risk group according to SAS and occurrence of complication ($P < 0.001$). Again, patient more prone to develop major complications including mortality in 30 day follow up had low mean SAS. Mean ASA was found to be inversely proportional to SAS. Increase in SAS was proved to be associated with good prognosis ($P < 0.0001$). Thus, it was proven that SAS was significant predictor of outcome in terms of postoperative major complications including mortality in 30-day post emergency surgeries under general anaesthesia.

Keywords: SAS; Post-operative complication; Emergency abdominal surgery

Introduction

To provide consistently low incidence of major complications for patient undergoing any operation, recognizing patients at high risk of developing a complication will contribute substantially to quality of operation and of cost reduction in surgery. Marked variability of post-operative outcomes is usually found due to difference in patient's preoperative co-morbid and risk factors [1]. The cardinal objective in the emergency situation is preparation and resuscitation for correction of deranged physiology. Inadequacy of which is a major contributory factor to morbidity and mortality. Intra-operative variable such as heart rate, blood pressure, arterial saturation, tissue perfusion and the surgical stress further contribute to variability in patient's risk of developing complications. However, the degree to which intra-operative performance further contributes to variation in patients' risk of complications remains unclear [1]. In operating room, surgeons have relied principally on "gut-feeling", instead of their objective assessment of the operative course for postoperative prognostication [2]. The Surgical Apgar Score (SAS) was determined by [3]. The SAS has been validated mainly in the west but less numbers of studies are currently available from Hospitals in our country. Here we prospectively evaluate postoperative complications according to SAS score.

Materials and Methods

This study was conducted at Department of General Surgery in Mamata General Hospital, Khammam, Telangana, India, a tertiary care teaching institute and hospital. The target population was patients undergoing laparotomy admitted to the general surgical wards, who met the eligibility criteria. This was a hospital based, single centre longitudinal prospective observational study from October 2014 to March 2015 including 66 patients.

Inclusion criteria: All patients above 16 yrs undergoing emergency abdominal surgeries under general anesthesia and willing to participate in study.

Exclusion criteria:

Surgeries under spinal / epidural / local anesthesia, not requiring intensive monitoring and regular follow-ups.

Elective general surgical procedures under general anesthesia.

Patients undergoing mini-laparotomy and laparoscopic procedures.

Age <16 years.

Patients that did not have their SAS registered in operative chart, when they left the operating room.

Patients who lost follow-up.

HIV +ve.

Patients with established metastatic and un-resectable tumours.

Patients without consent for participation in study.

Study endpoint (major complications): Patients were followed up for 30 days after surgery – telephonically even after discharge within study period for occurrence of any major complications or deaths which were considered as end points of study. Post op complications of Clavien grade III and greater, i.e., those that required re-surgical, endoscopic or radiological re-intervention for diagnosis of complications and those requiring intensive care admission were considered major complications [4]. Superficial surgical site infection and urinary tract infection were not considered major complications. Data collection included following

Personal data (Name, Age, Sex, Address, Occupation).

Co morbidities: Obesity, Hypertension, Pulmonary diseases, Cardiovascular diseases, Diabetes mellitus, Renal failure, Sepsis, CVA/TIA, Smoking, Cancer, Steroid therapy.

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Received October 24, 2016; **Accepted** November 15, 2016; **Published** November 22, 2016

Citation: Shaikh SU, Akther MJ. Surgical Apgar Score, Predictor of Post-Emergency Abdominal Surgery Outcome. Journal of Surgery [Jurnalul de chirurgie]. 2016; 12(4): 141-145 DOI:10.7438/1584-9341-12-4-2

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ASA (American Society of Anaesthesiologists) Class.

Surgical procedure executed.

Intra-operative variables for surgical apgar scoring (Table I).

Major complications or deaths within 30 days of surgery (End point of study).

The SAS was calculated at the end of emergency open abdominal surgery from the EBL, lowest MAP and lowest H.R. recorded during the operation. The score was the sum of the points from each category. Data such as lowest heart rate and lowest mean arterial pressures reached during the procedure were collected from the anesthesiologist's records (manual). Occurrence of pathologic bradyarrhythmia, including sinus arrest, atrioventricular block or dissociation, junctional or ventricular escapes rhythms, and asystole, also receives 0 points for lowest heart rate. Extra physiologic values of HR (<20/min or >200/min) and MAP (<25 mmHg or >180 mmHg were excluded. Estimated blood loss was calculated using the formulae [5].

$$\text{Blood loss} = [(\text{EBV} \times (\text{H}_i - \text{H}_p) / \{ (\text{Hct}_i + \text{Hct}_p) / 2 \}) + (500 \times \text{T}_u)] \text{ [5]}$$

[Estimated blood volume (EBV) is assumed to be 70 cm³/kg, H_i and H_p represent pre-and post-operative haemoglobin, Hct_i and Hct_p represent pre-and post-operative hematocrit, T_u is the sum of autologous whole blood (ABW), packed red blood cells (PRBC), and cell saver (CS) units (FFP, Cryoprecipitate) transfused].

Surgeries performed were emergency exploratory laparotomies (adhesiolysis, intestinal perforation repairs, resection and anastomosis for gangrenous bowel, appendectomies for acute appendicitis (perforated with or without gangrenous changes), Hernioraphies for obstructed ventral hernias, splenectomy for grade 3, 4, 5 splenic injuries due to blunt abdominal trauma. Patients were subsequently grouped into three categories based on their SAS for purposes of risk stratification, as in the study by Michael Dullo [6] which was as in the following table (Table Ia).

- Data management and analysis

All data were expressed as mean ± SD (Standard Deviation). Student's t-test was used for comparing between the two groups. The statistical significance between all the groups was evaluated by One-way ANOVA and with Bonforroni's post-hoc test using SPSS Software Version 16.0.

- Ethical considerations

Ethics and Research Committee reviewed the study protocol and granted approval prior to commencement of study.

Result

Demographic profile has been shown below (Table II and Table III).

In table II the trend of mean SAS increased as the age range decreased from more than 60 years to less than 40 years but it was not statistically significant (P=0.84) (Table II).

In table III mean SAS was not significantly related to gender (P=0.563) (Table III).

As mentioned in the table IV most common co-morbidities and risk factors were smoking (36.4%), hypertension (31.8%) and diabetes mellitus (28.8%). Hypertension, diabetes mellitus, renal failure were highly significant (p<0.001) for major complications (Table IV).

As mentioned in the table V the rate of occurrence of major complications increased as the number of preoperative co-morbidities increased among patients. Patients with 5 co-morbidities had 5-fold increases in complication rate compared to patients with single co-morbidity (100% vs 20%). As the number of preoperative co-

morbidities increased among patients, mean SAS trends to be of lower value, which was proven highly significant (P<0.0001). Patients with 4 or 5 co-morbidities had mean SAS <4, whereas patients with nil preoperative co-morbidities had mean SAS >6 (Table V).

The study included emergency laparotomies with 3 types of intra-operative pathological findings viz. acute intestinal obstruction, hollow viscous perforation, blunt trauma abdomen causing splenic injury, of these acute intestinal obstructions with/without gangrene was most common (31.8%) followed by gastro-duodenal perforation (18%). Major complication including mortality was highest in hollow viscous perforation with peritonitis (21.2%) followed by acute intestinal obstruction (13.6%) and splenic trauma (9.1%).

As mentioned in the table VI mean LHR and mean EBL were significantly related to SAS risk groups (p<0.0001), which meant a patient with low mean LHR and low mean EBL were associated with low risk (Table VI).

Most common major complication were pulmonary diseases (34.8%) including pneumonia (19.7%), prolonged ventilation (12.1%), pulmonary embolism (3%), followed by deep vein thrombosis, acute renal failure, wound disruption, sepsis and shock.

Table VII showed, there was significant association between type of risk and occurrence of complication (P<0.001). The cell of high risk group with complications had standardized residuals greater than 1.96. So, this cell contributed the most in predicting occurrence of complications i.e., high risk group patients were the strongest predictor of developing complications. Mortality was considered Clavien grade V of major complications. Out of total 7 deaths, 71.4% belonged to high risk group 28.6% patients in medium risk group (Table VII).

Among the patients in high risk group, 88% had multiple complications and one patient had maximum 5 complications. Death

Table I: Surgical Apgar score (component parameters).

Variables	0	1	2	3	4
Estimated blood loss, ml (EBL)	>1000	600-1000	101-600	<100	---
Lowest mean arterial pressure (mmhg) (LMAP)	<40	40-54	55-69	>70	---
Lowest heart rate/min (LHR)	>85	76-85	66-75	56-65	<55

Table Ia: Surgical Apgar score.

Risk group	SAS
High	0 to 4
Medium	5 to 7
Low	8 to 10

Table II: Age wise distribution of cases and mean surgical Apgar score.

Age (Yrs)	No of Patients-n (%)	Mean Age (Yrs) ± S.D.	Mean SAS	Mean ASA
17-40	33 (50%)	28.4 ± 6.5	6.2	1.4
41-50	14 (21.2%)	46.3 ± 3.6	4.7	3.0
51-60	11 (16.7%)	56.1 ± 2.8	4.4	3.4
>60	8 (12.1%)	67.2 ± 5.1	3.6	4.0
Total	66	41.5 ± 15.4	5.3	2.4

n-no. of patients, S.D.-Standard Deviation

Table III: Gender distribution of cases and mean surgical Apgar score.

Gender	No. of Patients-n (%)	Mean Age(Yrs) ± S.D.	Mean SAS	Mean ASA
Male	48 (72.7%)	42.2 ± 16	5.3	2.4
Female	18 (27.3%)	39.7 ± 13.9	5.1	2.3
Total	66 (100%)	41.5 ± 15.4	5.3	2.4

n-no. of Patients, S.D-Standard Deviation

Table IV: Pre-operative co-morbidity, risk factor and major complication.

Co-morbidity and risk factor	No. of Patients - n (%)	Major Complications		P Value
		Present	Absent	
Obesity	11 (16.7%)	8	3	0.0293 *
HTN	21 (31.8%)	18	3	<0.0001***
DM	19 (28.8%)	16	3	<0.0001***
CVS diseases	5 (7.6%)	4	1	NS
Pulmonary diseases	10 (15.1%)	7	3	NS
Renal Failure	12 (18.2%)	11	1	0.0002***
Sepsis	10 (15.1%)	9	1	0.0014**
CVA/TIA	2 (3.0%)	1	1	NS
Smoking	24 (36.4%)	16	8	0.0049**
Steroid	2 (3.0%)	1	1	NS

n- no. of patients, * p<0.05(significant), ** p<0.01(moderately significant), *** p<0.001(highly significant), NS- non-significant

Table V: Number of pre-operative co-morbidity, risk factors, major complication and mean SAS.

No. of Co-Morbidities and Risk factors	No. of Patients	Major Complication		Mean SAS
		Present n (%)	Absent n (%)	
0	25	0	25 (100%)	6.6
1	5	1 (20%)	4 (80%)	5.8
2	7	4 (57.1%)	3 (42.9%)	5.3
3	21	17 (81%)	4 (19%)	4.6
4	6	5 (83.3%)	1 (16.7%)	3.2
5	2	2 (100%)	0	1

n-no. of patients

Table VI: SAS risk groups and SAS parameters.

SAS Risk Groups	n (%)	Mean LHR ± S.D.	Mean LMAP ± S.D.	Mean EBL ± S.D.
High Risk (0-4)	18 (27.3%)	88.9 ± 14.1	63.4 ± 14.5	1329.7 ± 707.6
Medium Risk (5-7)	40 (60.6%)	77 ± 9.9	70.9 ± 10.2	467.6 ± 369.7
Low Risk (8-10)	8 (12.1%)	64.1 ± 8.4	77.2 ± 9.4	151.8 ± 139.0

n- number of patients, EBL-Estimated Blood Loss, LMAP-Lowest Mean Arterial Pressure, LHR-Lowest Heart Rate, S.D-Standard Deviation

Table VII: SAS risk groups and its relation to outcome in terms of major complications including mortality.

Risk Group	No. of patients n=66	Major Complication		λ ²	P-value
		Present n (%)	Absent n (%)		
High Risk (0-4)	18	17** (94.5%)	1 (5.5%)	29.878	0.000*
Medium Risk (5-7)	40	12 (30%)	28 (70%)		
Low Risk (8-10)	8	0	8 (100%)		

n-Number of patients, * P<0.001, statistically significant. Thus, there is significant association between type of risk and occurrence of complication (P=0.000), ** The cell has standardized residuals greater than 1.96. [value in parenthesis reflects % with respect to no. of patients in that risk group]

Table VIII: Relation among components of outcome with Mean SAS and Mean ASA.

Types of outcome	Total no. of Patients n (%)	Mean SAS	Mean ASA
Cases with mortality (M)	7 (24.1%)	2.8	3.8
Cases with major complication (MC)	29 (43.9%)	4	3.6
Cases with and without major complication (Total) (MC+N)	66 (100%)	5.3	2.4
Cases without major complication (N)	37 (56.1%)	6.3	1.4

n-number of patients

occurred in 27% of patients in high risk group; most common cause was sepsis secondary to peritonitis on average postoperative day (POD) 5.5. Among the patients in medium risk group, 5% had multiple complications and one patient had maximum 2 complications. Death occurred in 5% of patients in medium risk group; most common cause was sepsis secondary to peritonitis and pneumonia; on average POD 7. Among low risk group no patient developed postoperative major complication.

As mentioned in the table VIII mean SAS for the groups of patients with post-operative complications in decreasing order showed gradual increase in trend respectively, which was statistically significant (P<0.0001). Thus, it was proven that, there was highly significant

correlation between mean SAS and outcome in terms of development of major complications including mortality. So, patient more prone to develop major complications including mortality in 30 day follow up had low mean SAS (high risk). Mean ASA was found to be inversely proportional to SAS, which gradually increased as the SAS decreased. The published absolute mortality rates of the individual classes of ASA shows considerable variation, and with increasing mortality rate as classes number increases from I to V [7]. This correlates reverse association with SAS (Table VIII).

Discussion

The calculated surgical apgar scores ranged from one to nine and

had an average of 5.3 in this study. This was similar to studies by [6] in which SAS ranged from one to nine with a mean of 5.0. In studies by [8] surgical Apgar scores ranged from 6 to 10 with average of 8.

Table IX showed, the distribution of patients among different risk groups in our study were as per other literatures (Table IX).

From demographic data, it was found with decreasing scores, patients were increasingly older and more likely to be male which was comparable with studies by [11] but it was not statistically significant in present study. In study by [8] all demographic data were unrelated to SAS.

Table X showed the distribution of intra-operative parameters of patients among different risk groups in our study were as per other literatures. Mean EBL, mean LMAP and mean LHR in the group of perforation peritonitis with major complication were 697.2 ± 488.2 , 76.2 ± 13.1 and 69.1 ± 12.8 respectively. Similarly, mean EBL, mean LMAP and mean LHR in the group of splenic trauma with major complication were 1688.4 ± 868.9 , 61 ± 12.4 and 89.2 ± 18.8 respectively and mean EBL, mean LMAP and mean LHR in the group of acute intestinal obstruction were 360.4 ± 304.4 , 72.3 ± 10.1 and 78.1 ± 10.7 respectively. The reason of major loss of blood among splenic trauma cases was higher grade of injury like grade IV and V among the patients who underwent splenectomy. In present study, among some patient before proper resuscitations blood sample was sent for investigation, thus the value of haematocrit reflected was from concentrated blood sample. The haematocrit value after surgery was in fact true value because of intraoperative proper resuscitations. Damage control resuscitation as commonly part of management of blunt trauma cases, where patient was shifted to operation theatre even before complete resuscitation as happened among blunt trauma abdomen with splenic injury in present study where already patient had lost enough blood in intra-peritoneal compartment. As the EBL depended up on pre- and post-operative haematocrit, so above 2 elements already discussed most likely gave fallacy for estimated result. We found discrepancy of

blood loss between present study and other literatures, as present study included only emergency surgeries ↓ GA (Table X).

In the table XI rate of occurrence of major complications was higher in present study (94.5%) compared to other studies [3,6,11,12] this could probably be explained as present study included only emergency cases done under general anaesthesia with no prior preparation for co-morbid conditions and risk factors, where as other studies included both emergency and elective cases (Table XI).

It was demonstrated about the significant association ($P < 0.001$) between type of risk and occurrence of complication as per table VII and the ability of the SAS in identifying patients at higher than average risk of major post-operative complications as per table VIII. Thus, the predictive value of surgical apgar score to predict the complications was found to be significant. Patients with low scores were more likely to suffer multiple complications ($p < 0.0001$) as in study by [11]. In present study 56% patients with nil post-operative major complications, 15% patients with single major complication, 29% patients with multiple major complication had mean SAS of 6.3, 5.2 and 2.5 respectively.

Table XII showed the distribution of intra-operative parameters of patients with or without complications in our study were as per other literature. Among the cases with mortality, the mean lowest HR, mean lowest MAP and mean EBL were 89 ± 10.4 , 58.4 ± 9.2 and 869 ± 624.4 respectively (Table XII).

As expected, the SAS was strongly associated with mortality, lower SAS was associated with higher mortality rates. Scores ≤ 4 , score 5-7 and scores 8-10 had mortality 27.7%, 5% and 0% respectively which was comparable with study by [14]. in which SAS 0-4, SAS 5-8, SAS 9-10 had mortality 15.7%; 3.9%; 0.5%; respectively. In study by [12] 19.5% patients developed mortality with scores ≤ 4 and 0.1% in scores of 9 or 10 developed mortality.

Table IX: Comparison of distribution of SAS risk group.

Risk Group	[9]	[10]	[6]	Present Study
High	9%	10%	31.6%	27.3%
Medium	63%	39%	59.2%	60.6%
Low	29%	51%	9.2%	12.1%

Table X: Comparison of SAS parameters.

SAS parameters	[9]	[8]	[12]	[13]	Present Study
Mean LHR in bpm \pm SD	57.6 ± 11.3	70.2	63	64 ± 10.5	78.7 ± 10.7
Mean LMAP in mmHg. \pm SD	60.3 ± 9.9	80.1	61	63 ± 7.9	69.6 ± 11.3
Mean EBL in mL \pm SD	400 ± 620	31.6	200	650 ± 601.3	664.5 ± 405.4

Table XI: Comparison of risk group and outcome in terms of major complication and mortality.

Study	Major complication		Mortality	
	High risk	Low risk	High risk	Low risk
Gawande et al ⁹	58.6%	3.6%	13.8%	0
Scott et al ¹²	56.3%	5.0%	19.5%	0.1%
Regenbogen et al. ¹¹	54-75%	5-13%	-	-
Michael Dullo ⁶	58.3%	16.6%	-	-
Present Study	94.5%	0%	27.8%	0

Table XII: Comparison of SAS parameters and major complications.

SAS parameters	[12]			Present Study		
	Major complication		P value	Major complication		P value
	Present	Absent		Present	Absent	
MeanLHR \pm SD	63	58	$P < 0.001$	84 ± 13.8	74.6 ± 11.2	$P = 0.003^*$
Mean LMAP \pm SD	61	65	$P < 0.001$	63.6 ± 11.2	74.3 ± 10.7	$P = 0.000^*$
Mean EBL \pm SD	200	25	$P < 0.001$	987.4 ± 784	411.3 ± 288	$P = 0.000^*$

$P < 0.001$, * implies highly significant

Conclusion

Thus, it was proven that SAS was significant predictor of outcome in terms of postoperative major complications including mortality in 30-day post emergency surgeries under general anaesthesia.

Conflict of Interests

Authors have no conflict of interests to declare.

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