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ORIGINAL ARTICLE

# To Evaluate the Utility of Surgical Apgar Score in Predicting Postoperative Morbidity and Mortality in Patients Undergoing Laparotomy: A Prospective Observational Study

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## ABSTRACT

***Context:*** Postoperative complications following laparotomy remain a major cause of morbidity and mortality. Accurate intraoperative risk assessment tools are essential for early identification of high-risk patients. The Surgical Apgar Score (SAS) is a simple and objective scoring system based on intraoperative parameters including estimated blood loss, lowest mean arterial pressure, and lowest heart rate.

***Aim:*** To evaluate the utility of the Surgical Apgar Score in predicting postoperative morbidity and mortality in patients undergoing laparotomy.

***Study and Design:*** A prospective observational study was conducted at a tertiary care teaching hospital in India.

***Materials and Methods:*** A total of 130 patients undergoing laparotomy were included. The Surgical Apgar Score was calculated intraoperatively using lowest heart rate, lowest mean arterial pressure, and estimated blood loss. Patients were categorized into three risk groups: high risk (SAS 0–4), moderate risk (SAS 5–6),

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and low risk (SAS 7–10). Patients were followed for 30 days postoperatively to assess complications and mortality.

***Statistical Analysis Used:*** Statistical analysis was performed using Chi-square test.

***Results:*** The association between low Surgical Apgar Score and incidence of postoperative complications and mortality was statistically significant (p value <0.0001).

***Conclusion:*** The Surgical Apgar Score is a simple, reliable, and effective intraoperative tool for predicting postoperative morbidity and mortality following laparotomy. Its routine use can help in early risk stratification, better postoperative monitoring, and optimal allocation of critical care resources.

***Key Messages:***

1. Surgical Apgar Score is a simple intraoperative tool for early postoperative risk stratification.
2. Lower SAS is strongly associated with major complications and mortality after laparotomy.
3. Routine use of SAS can improve postoperative monitoring and ICU triage.

**KEYWORDS**

• Surgical Apgar Score • Laparotomy • Postoperative complications • Mortality • Risk prediction • Lowest heart rate • Lowest mean arterial pressure • Estimated blood loss

## INTRODUCTION

Exploratory laparotomy is a common surgical procedure performed for a wide range of abdominal conditions including trauma, perforation peritonitis, intestinal obstruction, and malignancies. Despite advances in surgical techniques and perioperative care, postoperative complications remain frequent and contribute significantly to morbidity and mortality[1].

Several scoring systems such as POSSUM, APACHE II, and ASA classification have been used for predicting postoperative outcomes[2]. However, these scoring systems often require complex calculations and multiple variables, limiting their routine clinical use.

The Surgical Apgar Score (SAS), introduced by Gawande et al., is a simple 10-point scoring system based on three intraoperative parameters: lowest heart rate, lowest mean arterial pressure, and estimated blood loss[3]. It provides a simple and objective measure of intraoperative physiological status. It has been used as a predictor of postoperative outcomes in various surgical procedures. Lower scores are associated with increased risk of postoperative complications and mortality.[4]

## MATERIALS AND METHODS

### Study design and setting

This hospital-based prospective observational study was carried out in the Department of General Surgery at a tertiary care teaching hospital in India for a duration of twelve months. This study was conducted after the approval of the Institutional Ethics Committee.

### Study population and sample size

The study included all patients undergoing laparotomy and fulfilling the selection criteria. A sample size of 130 patients per group was determined taking 80% study power and alpha error of 0.05 assuming major complications in 25% of participants as per previous studies and expecting 10% attrition/dropout/lost to follow-up. Patients were selected based on specific inclusion and exclusion criteria.

### Inclusion and Exclusion Criteria

Patients aged 15 years and above, both sexes, undergoing laparotomy and willing for participation were included in the study. Exclusion criteria included-Preoperative hemodynamically unstable patients, patients with bleeding disorders and/or on

anticoagulants, patients with pre-existing comorbid conditions like ischemic heart disease, Angina, CAD, stroke, etc. and patients undergoing major surgeries on other body parts within 30 days of laparotomy.

## METHODOLOGY

A total of 130 patients were selected according to selection criteria. A prior written informed consent was taken from the participants. A detailed clinical history was taken from all the patients consented for study and thorough physical examination was done for all patients. After a thorough clinical evaluation, all patients underwent routine pre-operative tests, such as a complete blood count, liver function tests, renal function tests, coagulation profile, blood sugar levels, an electrocardiogram, a chest X-ray and other relevant investigations.

Intra-Operative details like estimated amount of blood loss, lowest heart rate and lowest Mean Arterial Pressure were recorded. SAS was calculated on the basis of these parameters. Patients were grouped as: high risk (SAS 0–4), moderate risk (SAS 5–6) and low risk (SAS 7–10). Postoperative Complications and mortality were assessed. Follow-up was done for 30 days from date of surgery.

### Statistical Analysis

Statistical methods for analysis involved descriptive statistics such as mean, standard deviation and frequencies, and inferential statistics including chi-square test was used. The data was compiled in MS Excel, and other relevant software. The data has been presented in table & graphs where ever applicable. Data was be analysed as per objectives. P value <0.05 was considered as significant. Inferences were drawn with the help of appropriate significance.

### Ethical considerations

The study was conducted at our institution after obtaining ethical clearance from the Institutional Ethics Committee.

**Table 1:** Baseline characteristics of patients undergoing laparotomy

| Category | Number of cases | Percentage (%) |
|---|---|---|
| *Gender* | | |
| Male | 86 | 66.15 |
| Female | 44 | 33.85 |
| *Age group (years)* | | |
| 15-29 years | 30 | 23.1 |
| 30-39 years | 33 | 25.3 |
| 40-49 years | 21 | 16.2 |
| 50-59 years | 25 | 19.2 |
| 60 years and above | 21 | 16.2 |
| *Type of laparotomy* | | |
| Emergency | 91 | 70 |
| Elective | 39 | 30 |

**Table 2:** Distribution of Surgical Apgar Score among patients

| SAS | Risk Group | Number of cases (Percentage) | | |
|---|---|---|---|---|
| | | Total (130) | Male (86) | Female (44) |
| 0-4 | High risk | 25 (19.2%) | 18 (21%) | 7 (16%) |
| 5-6 | Intermediate risk | 44 (33.8%) | 32 (37.2%) | 12 (27.2%) |
| 7-10 | Low risk | 61 (47%) | 36 (41.8%) | 25 (56.8%) |

**Table 3:** Percentage of post-operative complications

| | Number of cases | Percentage (%) |
|---|---|---|
| Death | 13 | 10 |
| Anastomotic leakage | 3 | 2.3 |
| Burst abdomen | 6 | 4.6 |
| Deep SSI | 4 | 3.1 |
| Prolonged paralytic ileus | 5 | 3.8 |
| Systemic complications | 8 | 6.1 |
| Superficial SSI | 29 | 22.3 |
| Minor GI complications | 15 | 11.5 |
| Other minor complications | 13 | 10 |
| No complications | 53 | 40.8 |

**Table 4:** Association of SAS with postoperative complications and mortality

| SAS | Major complications | Minor complications | No complications | Mortality |
|---|---|---|---|---|
| SAS 0-4 (25) | 10 (40%) | 13 (52%) | 2 (8%) | 9 (36%) |
| SAS 5-6 (44) | 12 (27.3%) | 25 (56.8%) | 10 (55.7%) | 4 (9.1%) |
| SAS 7-10 (61) | 4 (6.5%) | 19 (31.1%) | 41 (67.2%) | 0 (0%) |

**Table 5:** Test of significance for major complications

| SAS | Major complications | No complications | Chi-square value | p-value | Significant (if p-value <0.05) |
|---|---|---|---|---|---|
| 0-4 (25) | 19 | 2 | 41.98 | <0.0001 | Yes |
| 7-10 (61) | 4 | 41 | Reference value | | |

**Table 6:** Test of significance for mortality

| SAS | Mortality | No complications | Chi-square value | p-value | Significant (if p-value <0.05) |
|---|---|---|---|---|---|
| 0-4 (25) | 9 | 2 | 40.7 | <0.0001 | Yes |
| 7-10 (61) | 0 | 41 | | Reference value | |

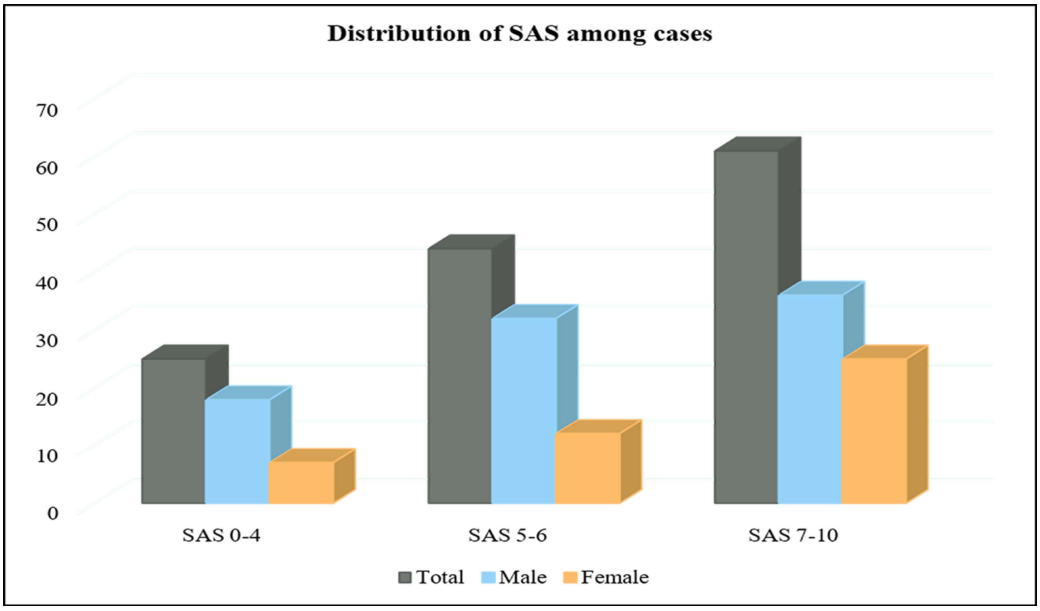


**Figure 1:** Distribution of Surgical Apgar Score among patients

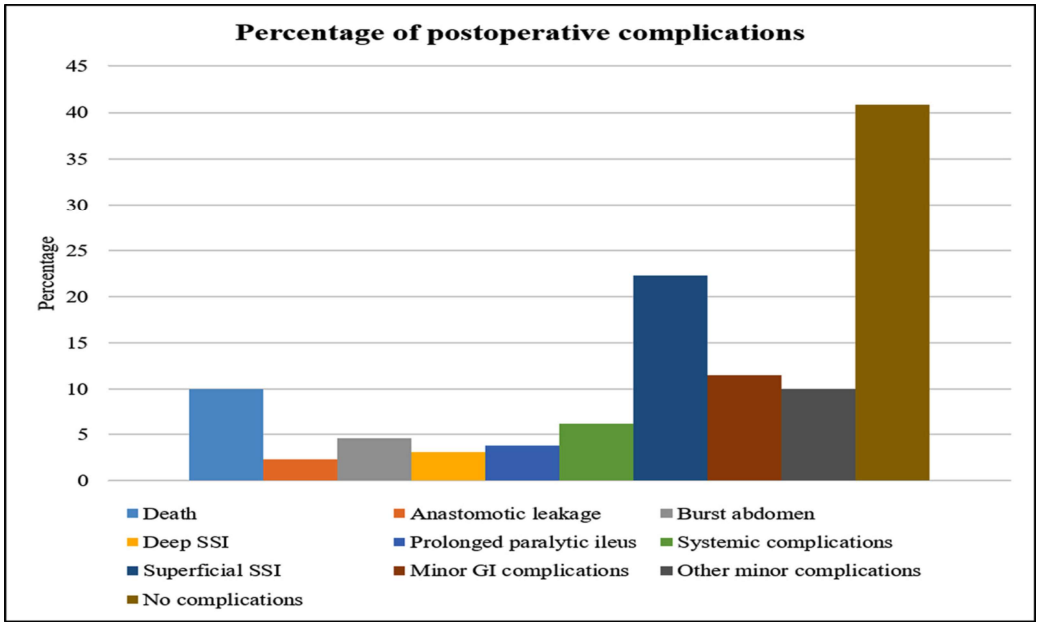


**Figure 2:** Percentage of post-operative complications

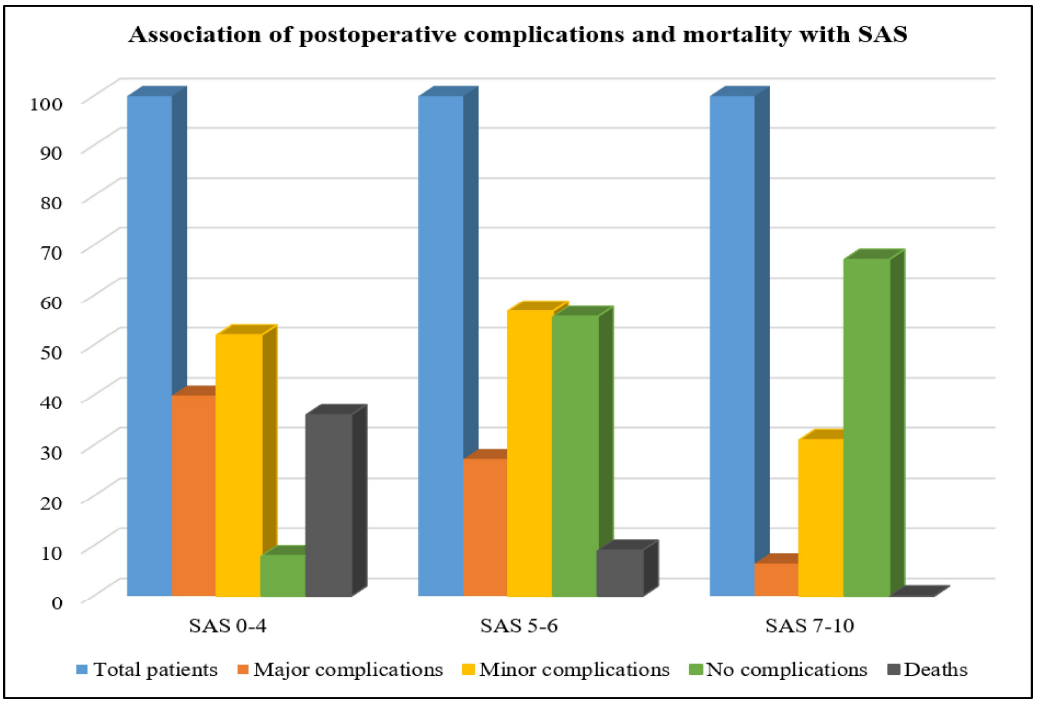


**Figure 3:** Association of postoperative complications and mortality with SAS

## RESULTS

A total of 130 patients who underwent laparotomy (emergency or elective) during the study period were included in the study.

The study population included both sexes, with the majority being males (66% of the cases). Maximum number of cases belonged to age group of 30-39 years. Mean age was around 41.6 years. Majority of the laparotomies were emergency surgeries (70%).

Patients were divided into three groups based on Surgical Apgar Score (SAS). Most of the cases fell into category of SAS of 7-10, accounting for 47% of all patients and 0-4 SAS category included only 19% of the cases.

The most common complication was superficial SSI accounting for 22.3% of all complications and least common was anastomotic leakage (2.3%). In this study, systemic complications included acute renal failure, cardiopulmonary complications, prolonged or unplanned intubation, sepsis, septic shock and SIRS. Minor GI complications included post-operative nausea and vomiting, transient paralytic ileus and constipation. Other minor complications were urinary complications like urinary tract infection or electrolyte imbalance.

A progressive increase in number of major complications was observed from 6.5% in 7-10 SAS category to 40% in 0-4 SAS category. Patients with SAS 0–4 had 11.7 times higher risk of major complications compared to SAS 7–10. Similarly, mortality was 36% in 0-4 SAS group while there were no deaths in SAS 7-10.

Chi-square test used for analysis and p-value was found to be <0.0001 for both post-operative major complications and mortality. So, Surgical Apgar Score of 4 or less shows statistically significant association with the incidence of post-operative major complications and mortality as compared to Surgical Apgar Score of 7 or more.

## DISCUSSION

Surgical Apgar Score offers a significant and practical assessment of the patient condition and the likelihood of major complications following the procedure. Compared with conventional scoring systems, the Surgical Apgar Score offers several advantages like simplicity, objectivity and availability. These attributes make it particularly useful in busy surgical units and resource limited settings, where complex scoring systems may not be feasible.

In this study, 66% of the patients were males. In study by Shah NJ et al and Dullo *et al,* there

were 78.7% and 75% males respectively.[4,6] The majority of research by Scott et al. and Gawande et al. on Surgical Apgar Score found a female preponderance of 56% to 65% in different study cohorts.[5] Kotera et al[7] involved 81.4% females while Santoshsingh

*et al*[8] had 42% females. However, no correlation has been observed between gender, Surgical Apgar Score and post-operative complications or mortality in these studies. Mean age in this study is around 43 years. Buzincu et al had mean age of 60 years[9] while in Shah NJ et al study, mean age was 35.18 years.[4] Previous researches have observed an average age distribution of 55.3 to 63.6 years.

Emergency laparotomies constituted 70% of the cases in this study. A study by Dullo et al in Kitui district hospital and school of medicine, included 87% emergency cases. The incidence of major complications and deaths, in emergency surgeries was 38.5% and 13.2%, whereas it was 10.2% and 2.6% in elective surgeries respectively. These findings are consistent with existing literature, Shah NJ et al had 85% emergency cases in which complications and mortality rate was 48.5% and13.2% respectively.[4] It indicated that the relative risk of predicting major complications and death was significantly higher for emergency surgeries as compared to elective surgeries.

The most striking observation in this study was the strong inverse relationship between Surgical Apgar Score and postoperative complications. The average SAS in this study was 6.55. Major complications occurred in 40% of the 25 patients with an Apgar score of less than 4, and 36% died within 30 days of surgery. On the other hand, only 6.5% of the 61 patients with a score between 7 and 10 experienced major complications, and there were no fatalities in this group.

Chi-Square test was applied for determining the p-value as a test of significance. The results were observed to be statistically significant, with the p value for post-operative major complications and mortality being <0.0001.

The findings of this study support the routine use of Surgical Apgar Score as an integral part of intra-operative assessment for predicting post operative outcomes.[10,11] Incorporating SAS into operative notes can aid surgeons and anaesthesiologists in anticipating postoperative needs, planning Intensive Care Unit admissions, prioritizing nursing care, and counselling patient relatives regarding prognosis.[12,13]

Furthermore, SAS can serve as a common communication tool among surgical teams, anaesthesiologists, and postoperative care providers, thereby improving continuity of care and patient safety.

## CONCLUSION

In order to predict post-operative morbidity and death in patients undergoing laparotomy, the surgical Apgar score has proven to be a useful measure. The findings of this study clearly demonstrate that the Surgical Apgar Score is a simple, reliable and effective intraoperative prognostic tool for early risk stratification of surgical patients. Owing to its simplicity, reproducibility, and applicability in both elective and emergency surgeries, the Surgical Apgar Score should be routinely incorporated into surgical practice, especially in resource-constrained healthcare settings. Larger multicentric studies with longer follow-up periods are recommended to further validate the role of Surgical Apgar Score and explore its integration with other perioperative risk assessment tools.

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**Conflict of Interest:** None declared.

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## REFERENCES

1. Vincent C., Moorthy K., Sarker S.K., Chang A., Darzi A.W. Systems approach to surgical quality and safety: from concept to measurement. Annals of surgery. 2004 Apr 1; 239(4): 475-82. DOI: 10.1097/01.sla.0000118753.22830.41
2. Barnett S., Moonesinghe S.R. Clinical risk scores to guide perioperative management. Postgraduate medical journal. 2011 Aug; 87(1030): 535 41. DOI: 10.1136/pgmj.2010.107169
3. Gawande A.A., Kwaan M.R., Regenbogen S.E., Lipsitz S.A., Zinner M.J. An Apgar score for surgery. Journal of the American College of Surgeons. 2007 Feb 1; 204(2): 201-8. DOI: 10.1016/j.jamcollsurg.2006.11.011
4. Shah N.J., Choudhary R.S., Jangir S.R., Patel D. Evaluation of Surgical Apgar Score (SAS)

in predicting post-laparotomy complications. DOI: 10.18203/2349-2902.isj20203778

5. Regenbogen S.E., Ehrenfeld J.M., Lipsitz S.R., Greenberg C.C., Hutter M.M., Gawande AA. Utility of the Surgical Apgar Score (SAS): validation in 4119 patients. Archives of Surgery. 2009 Jan 19; 144(1): 30-6. DOI:10.1001/archsurg.2008.504
6. Dullo M., Ogenda S.W.O., Nyaim E.O. Surgical Apgar Score predicts post laparotomy complications. Annals Afr Surg. 2013; 10(2): 24-9. DOI:10.4314/aas.v10i2.
7. Kotera A. the Surgical Apgar Score can help predict postoperative complications in femoral neck fracture: A 6-year retrospective cohort study. JA clinical reports. 2018; 4: 67. DOI: 10.1186/s40981-018-0205-y
8. Santoshsingh S.R., Sathyakrishna B.R. Surgical Apgar Score (SAS). A simple prognostic tool in surgery. International Journal of Scientific Study. 2016; 4(4): 1-5. DOI: 10.9790/0853-2104142530
9. Buzincu I., Tănase S., Puf C., Ristescu I., Rusu D.M., Pătrășcanu E., Gavril L., Grigoraș I. Surgical Apgar Score (SAS) predictive value for early postoperative organ dysfunction in cancer patients. Acta Chirurgica Belgica. 2022 Nov 2; 122(6): 411-9. DOI:10.1080/00015458.2021.1920683
10. Thorn C.C., Chan M., Sinha N., Harrison R.A. Utility of the Surgical Apgar Score (SAS) in a district general hospital. World journal of surgery. 2012 May; 36(5): 1066-73. DOI 10.1007/s00268-012-1495-2
11. Ziewacz J.E., Davis M.C., Lau D., El-Sayed A.M., Regenbogen S.E., Sullivan S.E., Mashour GA. Validation of the Surgical Apgar Score (SAS) in a neurosurgical patient population. Journal of neurosurgery. 2013 Feb 1; 118(2): 270-9. DOI: 10.3171/2012.10.JNS12436.
12. Sobol J.B., Gershengorn H.B., Wunsch H., Li G. The Surgical Apgar Score (SAS) is strongly associated with intensive care unit admission after high-risk intraabdominal surgery. Anesthesia & Analgesia. 2013 Aug 1; 117(2): 438-46. DOI: 10.1213/ANE.0b013e31829180b7
13. Lin Y.C., Chen Y.C., Yang C.H., Su N.Y. Surgical Apgar Score (SAS) is strongly associated with postoperative ICU admission. Scientific reports. 2021 Jan 8;11(1):115. DOI: 10.1038/s41598-020-80393-z