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Predictability of Surgical Apgar Score for postoperative outcomes in hip fractures: A prospective observational study

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ABSTRACT

Objective: To assess the utility and validation of the Surgical Apgar Score (SAS) in predicting postoperative complications of hip fractures.

Methods: This prospective observational study included patients who received operations for hip fractures from 1st March 2017 to 30th June 2018 at the Department of Orthopedic Surgery, Liaquat National Hospital and Medical College. Patients were followed at the outpatient department, and complications and mortality were recorded through phone calls. The predictability of SAS for postoperative complications was assessed.

Results: SAS≤4 was found as a significant predictor for postoperative pulmonary (P=0.008) and cardiac complications (P=0.042) as well as blood transfusion required to optimize postoperative hemoglobin (P=0.03) in the patients with hip fractures.

Conclusions: SAS provides reliable feedback information about patients' postoperative risk during the surgery. Hip fracture patients with scores≤4 should be monitored for major complications both during the hospital admission and after the discharge.

KEYWORDS: Hip fractures; Surgical Apgar Score; Postoperative outcomes

1. Introduction

The term "hip fracture" most commonly refers to the femoral neck and trochanteric fractures including intertrochanteric and subtrochanteric fractures or a combination of both. In the geriatric population, hip fractures usually occur due to minor trauma because of osteoporotic bones.

Hip fracture is a major public health problem in the Asian population, which is usually associated with significant postoperative systemic complications and high mortality due to the burden of major surgery in a morbid patient[1]. For these postoperative complications, physicians need predictive tools to analyze the perioperative risk. Several algorithms have been employed for perioperative risk assessment, for example, the American Society of Anesthesiologists Physical Status Classification System (ASA classification)[2,3], the Physiologic and Operative Severity Score for Enumeration of Mortality and Morbidity[4] and Surgical Outcome Risk Tool[5]. According to Sakan *et al.*, Surgical Apgar Score (SAS) has been shown as a proven independent predictor of major postoperative complications and mortality within 30 d after different types of surgery[6]. SAS is a simple and objective predictive tool, with three easily calculated variables, namely estimated blood loss, lowest heart rate, and lowest mean arterial pressure. These variables are derived after surgery from intraoperative anesthesia records[7].

Sakan *et al.* performed a retrospective study on the implementation of SAS on 43 hip fracture patients and concluded that the score≤4 was a significant predictor for the major postoperative complications within 30 d of surgery[6]. Gawande *et al.* performed a retrospective study on Apgar Scores for surgery on 303 patients and concluded that a 10-point score was significantly associated with major complications or death within 30 d after surgery[8].

We performed a prospective study at a tertiary care hospital to observe the utility and value of SAS in predicting the major postoperative complications.

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2. Materials and methods

2.1. Study design

This was a prospective observational study conducted at the Department of Orthopaedic Surgery, Liaquat National Hospital and Medical College, a 700-bedded tertiary care hospital.

2.2. Ethical approval

Approval from the Ethical Review Committee of Liaquat National Hospital and Medical College was obtained (Approval number: 1054/2017) and written informed consent was taken from all patients included in the study.

2.3. Participants

The patients aged older than 18 years who had undergone traumatic hip fracture surgery between 1th March 2017 and 30th June 2018, were included in the study. The patients who did not give consent and those who failed to follow up were excluded. We finally achieved a cohort of 150 patients, which was ample considering only the hip fracture patients as a study group. This was also a considerable number compared with the previously published literature[5].

2.4. Calculation of SAS

The SAS was calculated as the sum of three perioperative variables obtained from the operative handwritten anesthesia records of each patient[6]. The three variables were estimated blood loss, lowest heart rate, and lowest mean arterial pressure. Each was allocated scoring points according to the measured values (Table 1). The sum of the points for these three preoperative variables gives the total score value for each particular patient. The surgery time was taken as the time from skin incision to skin closure to exclude the blood-pressure and heart rate-lowering effects of anesthetic drugs during induction and intubation or during spinal[4]. As the patients with SAS of 4 or less than 4 are usually few as well as reported by other researchers[9,10], so patients were categorized into two groups, *i.e.* SAS≤4 and SAS>4. The preoperative variables were age, sex, comorbidities, ASA status, fracture pattern, type of surgery, and anesthesia technique.

Table 1. Calculation of Surgical Apgar Score[3].

Parameters	Surgical Apgar Scores				
	0	1	2	3	4
EBL (mL)	>1 000	601-1 000	101-600	1≤100	--
LMAP (mmHg)	<40	40-54	55-70	≥70	--
LHR (per min)	>85	76-85	66-75	56-65	≤55

EBL: Estimated blood loss; LMAP: Lowest mean arterial pressure; LHR: Lowest heart rate.

2.5. Complications

Postoperative complications recorded during hospital stay and within 30 d after the operation were postoperative bleeding that required transfusion of at least four units of packed red blood cells within 3 d of surgery, cardiovascular complications (cardiac arrest, myocardial infarction, deep venous thrombosis, pulmonary embolism, stroke or transient ischemic attack), respiratory problems (unplanned intubation, mechanical ventilation for 48 h or more, pneumonia, sepsis, septic shock) and renal issues (acute renal failure, renal insufficiency requiring dialysis). Mortality was recorded during 30 d follow-up by phone call to the patient or their family member and outpatient department visit.

2.6. Statistical analysis

Statistical analysis was done using SPSS Version 20. All descriptive data were expressed as numbers and percentages. Preoperative variables and postoperative complications of the two groups were compared using the Pearson *Chi*-square test. The significance level of tests was set as α=0.05.

3. Results

The total number of patients operated on this duration for hip fracture was 150 after excluding 18 patients who failed to follow up and 10 patients who did not give consent. Preoperative characteristics of the two groups were compared, and the results are shown in Table 2. Among these 150 patients, 79 were males and 71 females, with a mean age of (62±14) years. The major fracture pattern was intertrochanteric fracture, and the most common surgery performed was dynamic hip screw. Pulmonary problem was the most common pre-existing disease. The mean of perioperative variables used to calculate the SAS were estimated blood loss (275.62 mL), lowest mean arterial pressure (68.24 mmHg) and lowest heart rate (78.45 beats/min). Table 3 illustrates the association between SAS and postoperative complications. Pulmonary and cardiac complications occurred significantly more frequently in patients with SAS≤4 (P=0.008 and 0.042, respectively). More than four packed cell blood transfusions were required postoperatively in 70.8% of patients with SAS≤4 (P=0.036). SAS was not significant in predicting renal complications and 30 d mortality among hip fracture patients. As two groups were also different in fracture pattern, type of operation, pre-existing pulmonary and cardiac disease, a multivariable logistic regression analysis was done to confirm the predictability of SAS for these complications (Table 4).

4. Discussion

This study was conducted to predict the morbidity and mortality

Table 2. Preoperative characteristics and their relation with Surgical Apgar Score.

Parameters	*N* (%)	SAS≤4	SAS>4	χ^2	*P*-value
Gender					
Male (%)	79 (52.7%)	11 (26.9%)	68 (62.4%)	15.109	0.413
Female (%)	71 (47.3%)	30 (73.1%)	41 (37.6%)		
ASA class					
2	42 (28%)	3 (7.4%)	39 (35.8%)	23.061	0.356
3	103 (68.7%)	33 (80.4%)	70 (64.2%)		
4	5 (3.3%)	5 (12.2%)	0 (0)		
Fracture pattern					
Neck of femur	49 (32.6%)	14 (34.2%)	35 (32.2%)	2.890	0.042*
Intertrochanteric	88 (58.6%)	21 (51.2%)	67 (61.4%)		
Subtrochanteric	13 (8.6%)	6 (14.6%)	7 (6.4%)		
Type of operation					
Dynamic hip screw	88 (58.6%)	21 (51.2%)	67 (61.4%)	13.569	0.034*
Cannulated hip screw	16 (10.6%)	0 (0)	16 (14.6%)		
Hemiarthroplasty	33 (22.2%)	13 (31.7%)	20 (18.5%)		
Proximal femur nailing	13 (8.6%)	7 (17.1%)	6 (5.5%)		
Anesthesia technique					
General	36 (24.0%)	13 (31.7%)	23 (21.1%)	1.838	0.678
Spinal	114 (76.0%)	28 (68.3%)	86 (78.9%)		
Comorbidities					
Pulmonary disease					
No	83 (55.4%)	17 (41.4%)	66 (60.5%)	31.453	0.048*
Yes	67 (44.6%)	24 (58.6%)	43 (39.5%)		
Cardiac disease					
No	117 (78.0%)	19 (46.3%)	98 (89.9%)	32.954	0.049*
Yes	33 (22.0%)	22 (53.6%)	11 (10.1%)		
Renal disease					
No	105 (70.0%)	29 (70.7%)	76 (69.7%)	0.014	0.276
Yes	45 (30.0%)	12 (29.3%)	33 (30.3%)		
Coagulopathy					
No	131 (87.4%)	36 (87.8%)	95 (87.1%)	45.741	0.365
Yes	19 (12.6%)	5 (12.2%)	14 (12.9%)		

*: $P<0.05$.

Table 3. Relationship between mean Surgical Apgar Score (SAS) and postoperative morbidity and mortality.

Postoperative complications	SAS≤4 [*n* (%)]	SAS>4 [*n* (%)]	χ^2	*P*-value
Pulmonary				
Yes	25 (61%)	56 (51.4%)	1.105	0.008*
No	16 (39%)	53 (48.6%)		
Cardiac				
Yes	22 (53.7%)	21 (19%)	17.234	0.042*
No	19 (46.3%)	88 (81%)		
Renal				
Yes	16 (39%)	24 (20%)	4.406	0.543
No	25 (61%)	85 (80%)		
Transfusion required				
≥4 packed cell volume	29 (70.8%)	6 (5.5%)	70.859	0.036*
<4 packed cell volume	12 (29.2%)	103 (94.5%)		
Mortality				
Yes	12 (29.3%)	0 (0)	34.677	0.682
No	29 (70.7%)	109 (100%)		

*: $P<0.05$.

Table 4. Multivariable analysis.

Variables	Odds ratio	95%*CI*
Fracture pattern (Intertrochanteric pattern *vs.* other patterns)	0.27	0.10-0.85
Type of operation (dynamic hip screw *vs.* other surgeries)	0.59	0.33-0.89
Pulmonary disease (no *vs.* yes)	0.75	0.45-0.91
Cardiac disease (no *vs.* yes)	0.89	0.49-0.94
Surgical Apgar Score (>4 *vs.* ≤4)	0.14	0.02-0.11

postoperatively among hip fracture patients. As patients with hip fractures usually have a sub-optimal medical condition, comorbidities, and compromised cardiopulmonary reserves, preoperative variables like age and ASA physical status are sometimes not sufficient to predict early and late postoperative course and the need for ICU surveillance. This study showed that SAS≤4 was a significant predictor for the development of 30-day major complications. The patients with hip fracture having a score ≤4 should be identified by physicians as alarming cases who need intensive postoperative monitoring. In the current study, the lower lowest heart rate and estimated blood loss were associated with higher SAS values and better patient outcomes. Thus, the SAS value would be higher by avoiding higher heart rate and hypotension, and by applying a surgical technique with better hemostasis. Hence, intraoperative vital signs and hemostasis status are important predictors of the patient's outcome[11,12].

Sakan *et al.* in their study concluded that SAS≤4 in posttraumatic hip fracture patients was a significant predictor for the 30-day major postoperative complications. He also suggested that posttraumatic hip fracture patients with SAS≤4 should be under strict surveillance after surgery[6]. However, the SAS was not significant in the prediction of 30-day mortality, which is consistent with findings of the current study.

Regenbogen *et al.* conducted a study on 4 119 patients and concluded that the score can be effective in identifying patients at higher or lower risk of major complications and/or death after surgery than average likelihood and may be useful for evaluating interventions to prevent poor outcomes[10]. These results are consistent with the conclusion of the current study.

Reynolds *et al.* conducted a study on 123 864 patients in all surgical subspecialties and concluded that lower SAS were associated with an increased risk of death[7]. Otherwise, SAS was not found as a predictive factor for 30-day mortality in our study.

Limitations of the current study are that, first, it was conducted in a single institution; Second, all data have been taken from handwritten anesthesia records and the reliability cannot be assessed. Also, blood loss estimation could be questionable. However, the studies have reported that SAS blood loss estimation categories closely match the observer's blood loss volume, especially if the estimation is made by the anesthesiologist[13,14].

To conclude, this study suggests that the calculation of SAS provides reliable feedback information during the surgery about patients' postoperative risk. However, considering the limitations of the study, large multi-centered studies are required to examine the efficiency of SAS and promote it as a tool to predict the risk of postoperative complications.

Conflict of interest statement

The authors report no conflict of interest.

Authors' contributions

Farhan Haroon did the literature search, prepared the synopsis and collected the data. Sajid Younus and Noman Memon also contributed to data collection and paper writing. Naveed Memon did the statistical analysis. Asif Peracha supervised the whole project.

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