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Does ASA Classification Effect Hospital Course and Post-Operative Complications Following Oral and Maxillofacial Surgical Procedures?

Benjamin Kurnick BA[1], Josef Madrigal MD[2], Albert Y. Han MD PhD[2], Peyman Benharash MD[3], Maie A. St. John MD PhD[2], Tara Aghaloo DDS MD PhD[1]

[1] Division of Oral and Maxillofacial Surgery, UCLA School of Dentistry, Los Angeles, CA
[2] Department of Head and Neck Surgery, David Geffen School of Medicine at UCLA, Los Angeles, CA
[3] Division of Cardiothoracic Surgery, Department of Surgery, David Geffen School of Medicine at UCLA

Corresponding Author:
Benjamin Kurnick, BA
UCLA School of Dentistry, Section of Oral and Maxillofacial Surgery
10833 Le Conte Avenue
Los Angeles, CA 90095-1668
Phone: (310) 554-3271
Fax: (310) 794-2198
bkurnick@ucla.edu

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Objective: The purpose of the present study was to assess the duration of operative time and outcomes related to patients with an increased American Society of Anesthesiologists (ASA) Physical Status classification in the setting of hospital-based maxillofacial surgical procedures.

Study Design: A retrospective multi-institutional cohort study utilizing the American College of Surgeons National Surgical Quality Improvement Program database to enroll patients who underwent maxillofacial procedures between 2012 and 2019. The primary independent variable was ASA Physical Status Classification (I, II, III, IV). Descriptive, univariate, and multiple logistic regression statistics were utilized to evaluate the relationship between ASA Classification, body mass index (BMI), operative time, and perioperative complications.

Results: The study cohort was comprised of 1,807 subjects, with 946 males and 861 females. ASA Physical Status Classification ranged from Class I to IV. On bivariate analysis, patients classified as ASA III (286 [IQR 152-503], P<0.001) and ASA IV (412 [IQR 156.5-547.5], P=0.003) were associated with longer operative times. The risk of perioperative complications was 2.6% for ASA I patients (n=19), 6.3% for ASA II (n=48; P=0.005), 24.5% for ASA III (n=76; P<0.001), and 55.0% for ASA IV (n=11; P<0.001). On multivariate-adjusted analysis, using ASA I as the reference, ASA III (β +53.2 minutes, 95% Confidence Interval [CI] +28.6 to +77.8, P<0.001) and ASA IV (β +81.5 minutes, 95% Confidence Interval [CI] +21.0 to +141.9, P=0.008) were variables associated with longer operative time.

Conclusions: Increased ASA Physical Status Classification was associated with increased operative time and perioperative complications.

Introduction

A growing percentage of Americans suffer from at least one chronic disease (approximately 45% as of 2018).[1] The likelihood of medical conditions occurring increases with age, and as the life expectancy increases it is reasonable to expect that the overall number of patients with comorbidities will expand. The American Society of Anesthesiologists (ASA) Physical Status Classification, first introduced in 1941, was established as a tool for healthcare providers to better predict operative risk.[2] Included as variables with which to assign accurate ASA classes are body mass index (BMI), current/former smoker, EtOH habits, diabetes, and hypertension.[2]

The association between increased ASA classification, BMI, operative time, and perioperative complications is well substantiated in the literature. Prospective and retrospective studies across various surgical procedures have documented a positive association between the duration of surgical procedures and complications, such as surgical site infection (SSI), venous thromboembolism (VTE), bleeding, hematoma formation, and necrosis. Patients with increased ASA Classification have been shown to have increased operative surgical time, which may thus lead to more perioperative complications.[3] Additionally, individuals classified as ASA III and IV were found to have higher rates of both medical and technical complications, including myocardial infarction, wound infection, and nerve injury.[4,5] Such findings have been attributed to the physical challenges of operating on medically complex individuals as well as their associated comorbidities, placing them at higher risk of cardiovascular and pulmonary events.[4]

Given the increasing rates of Americans with chronic diseases and the scarcity of clinical data on its impact on oral and maxillofacial surgical patients, further exploration of this topic is warranted.[1] While the association of ASA Classification with surgical complications in

maxillofacial procedures has been investigated in limited series, no prior studies have examined surgical operative time and perioperative complications of this group in large datasets. Additionally, no study has examined the association between increasing ASA classification, perioperative complications, and operative time in maxillofacial surgical procedures. Using a multi-institution dataset, the present study thus assessed the impact of ASA Classification on operative time and duration of hospitalization as well as rates of complication and readmission 30 days after the initial operation. The investigators hypothesized that patients with higher ASA Classification undergoing maxillofacial procedures were at a greater risk of perioperative complications, portending longer operative times and lengths of hospital stay.

Methods

This was a retrospective cohort study using the 2012-2019 American College of Surgeons' National Surgical Quality Improvement Program (ACS-NSQIP) database. In order to provide participating institutions the ability to identify areas of improvement, ACS-NSQIP collects patient and operative data from over 700 institutions, representing approximately 11.5% of US hospitals. Due to the de-identified nature of this dataset, the study was deemed exempt by the UCLA Institutional Review Board (IRB #22-000256).

All adults (≥18 years) who underwent specific mandibular, maxillary, midface, or maxillary/mandibular maxillofacial procedures were identified using relevant Current Procedural Terminology (CPT) codes (**Table 1**). Mandibular surgical procedures included genioplasty, mandibular augmentation, reconstruction of the mandible, mandibular bone graft, and segmental osteotomy of the mandible. Maxillary surgical procedures included LeFort I osteotomies and segmental osteotomy of the maxilla. Midface maxillofacial surgical procedures included LeFort II and III osteotomies, reconstruction of the midface, facial bone osteoplasty, and bone grafts of the nasal, maxillary or malar areas. Maxillary/Mandibular procedures included applying a metal plate to reconstruct and repair defects inhibiting functions of jaws. Patients who underwent non-elective or emergency procedures as well as those with missing height and weight data were excluded (n=74, 3.9% of original cohort). Body mass index was calculated with patients subsequently stratified into underweight (<18.5), normal weight (18.5-25.0), and overweight/obese (>25.0) groups.

Relevant patient and hospital characteristics were subsequently tabulated utilizing the ACS-NSQIP data dictionary, including age, sex, race, inpatient status, ASA classification, and select comorbidities. The primary outcome of interest was operative time. Several secondary

outcomes were also assessed, including hospital length of stay, perioperative complications, and readmission within 30 days of index discharge. Complications captured by the ACS-NSQIP included infectious, respiratory, transfusion, and wound-related events.

Categorical variables are reported as proportions while continuous variables are reported as means with standard deviation and medians with interquartile ranges (25%-75%). Cuzick's test was utilized to assess the significance of temporal trends (NPTrend). Bivariate analysis was conducted using chi-square test and Mann-Whitney U test for categorical and continuous variables, respectively. To evaluate the independent association of ASA Physical Status Classification with operative time, the investigators designed a multivariable regression model with the inclusion of clinically relevant variables. The final model included age, sex, BMI, and procedural type. Significance was set at $P< 0.05$. All analyses were performed using Stata version 16.1 (Statacorp, College Station, TX) software.

Results

Of 1,807 patients undergoing maxillofacial operations, 39.9% (n=720) were classified as ASA I, 41.9% (n=757) as ASA II, 17.1% (n=310) classified as ASA III, and 1.1% (n=20) classified as ASA IV (**Table 2**). During the study period, there was no significant change in the average ASA Classification of the study population (**Figure 1**). Compared to their ASA I counterparts, patients who were ASA II (34 [IQR 24-48], P<0.001), III (58 [IQR 45-67], P<0.001), and IV (62.5 [IQR 52.5-74.5], P<0.001) were older (vs ASA I 24 [IQR 21-30] years). In addition, these patients were more frequently classified as overweight (ASA I BMI 24.0 [IQR 21.5-26.6] vs ASA II BMI 25.8 [IQR 22.5-29.9]; P<0.001, ASA III BMI 26.7 [IQR 23.0-31.2]; P<0.001, ASA IV BMI 27.2 [IQR 23.1.5-32.4]; P=0.215). Furthermore, the ASA III patient population had a statistically significant increase in comorbidities, including hypertension (41.6%, n=129, P<0.001), diabetes (10.7%, n=33, P<0.001), and smoking (24.5%, n=76, P<0.001). The ASA IV patient population had a statistically significant increase in hypertension (60.0%, n=12, P<0.001), diabetes (25.0%, n=5, P<0.001).

On bivariate analysis, patients classified as ASA III and IV experienced longer operative times than ASA I individuals (ASA III 286 [IQR 152-503] minutes; P<0.001 and ASA IV 412 [IQR 156.5-547.5] minutes; P<0.001 vs ASA I 162 [103.5-235.5] minutes) (**Table 3**). In addition, these patients had a statistically significant increase in duration of hospitalization (ASA I 1 [IQR 0-1] days vs ASA II 1 [IQR 0-1.5] days; P=0.001, ASA III 4 [IQR 1-9] days; P<0.001, and ASA IV 7 [IQR 1-17] days; P<0.001). Furthermore, perioperative complication incidence in ASA II (6.3% (n=48); P=0.005), ASA III (24.5% (n=76); P<0.001), and ASA IV (55.0% (n=11): P<0.001) patients were significantly increased compared to ASA I (2.6% (n=19) patients. Also,

hospital readmission within 30 days was increased in ASA III (6.5% (n=20); P<0.001) and ASA IV (15.0% (n=3); P<0.001) compared to ASA I (1.0% (n=7)) (**Table 3**).

After multivariable adjustment, ASA Classification remained a statistically significant factor in prolonged operative time. Using ASA Class I as the reference, ASA Class III (β +53.2 minutes, 95% Confidence Interval [CI] +28.6 to +77.8, P<0.001) and ASA Class IV (β +81.5 minutes, 95% Confidence Interval [CI] +21.0 to +141.9, P=0.008) were variables associated with longer operative time (**Table 4**). Notable, with outpatient procedures as reference, inpatient procedures had longer operative times (β +117.6 minutes, 95% CI +103.9 to +131.4, P<0.001).

Discussion

This study observes the increasing rates of health risks and comorbidities among patients and their impact on perioperative complications in relation to maxillofacial surgical procedures. As such, oral and maxillofacial surgeons will more frequently encounter a larger number of medically complex patients. In this study, patients with increased ASA Classification are more often diagnosed with hypertension and diabetes, which have been previously found to portend worse outcomes. This study found that there was a statistically notable increase in perioperative complications between ASA I and ASA II, III, and IV patients. Additionally, the investigators computed that increased patients with greater ASA Classifications had a longer operative time on both bivariate analysis and multivariable analysis, as compared to ASA I Classification.

In 1941, the American Society of Anesthesiologists (ASA) created the ASA Classification system to standardize a categorization for patients to swiftly characterize their physical status and potential risks.[6-8] One of the defining features of this classification system is that an increase in BMI is directly correlated with an increase in risk associated with anesthesia, as a BMI between 30 and 35 is ASA Classification II and a BMI above 35, signifying morbid obesity, is ASA Classification III.[7] Additionally, the increased adiposity in overweight and obese patients impacts the solubility and distribution of lipophilic anesthetic agents, which suggests difficulty in appropriately sustaining and withdrawing anesthesia. Obesity is associated with an increased cardiac output and total blood volume, which further alters arterial and venous drug distribution, as well as peak drug concentration and clearance.[9] This difficulty infers the need for increased pharmacologic dosage for anesthetic induction and maintenance, which may be associated with the increased operative time in patients with a greater ASA classification. Dann et al. suggested that both the length of time under anesthesia and the duration of the surgical

procedure strongly correlated with postoperative morbidity, surgical outcomes, and the need for subsequent inpatient surgical care.[10-14] This will require oral and maxillofacial surgeons to optimize preoperative preparation in patients with comorbidities, prepare for potential prolonged hospital stay, and decrease operative time as much as possible.

On bivariate analysis, the data demonstrates that increased ASA Classification led to longer operative time. This was confirmed by performing a risk-adjusted multivariate analysis, where increased operative times was associated with ASA III and ASA IV Classifications, increased age, inpatient procedures, and combined maxillary/mandibular procedure. When looking at the multivariate analysis, the ASA Classification is primarily responsible for increased operative time (**Table 4**). The beta-coefficients calculated in the multivariate analysis show that the most tightly associated factors with increased operative time were ASA III and ASA IV Classifications (**Table 4**).

This study suggests that ASA III and IV patients undergoing maxillofacial procedures may be at an increased risk of perioperative complication, which is consistent with previous literature.[15] The decision to perform major surgical procedures on ASA III and ASA IV patients is often influenced by the severity of the patients maxillofacial condition, and the surgeon should be expected to observe a higher complication rate with higher ASA status. This may also influence the longer operative time and higher incidence of complication observed in procedures performed on ASA III and ASA IV patients, as these surgeries may more likely be due to necessity and complexity compared to a potentially more elective surgical population in ASA I and ASA II patients.

Of the variables strongly associated with an increased ASA Classification, obesity is linked to a continuous state of low-grade inflammation, resulting from chronic activation of the

innate immune system, which can subsequently lead to insulin resistance and diabetes. Additional medical conditions with known links to increased inflammation include smoking, increased age, hypertension, and cardiovascular disease.[16] Patients with at least one of these chronic medical conditions can present with amplified inflammatory responses, oxidative stress, and further metabolic dysfunction and immunosuppression, leading to possibly increased perioperative complications in patients undergoing maxillofacial surgical procedures.[15] Suggested surgical protocol alterations for ASA III and IV patients in urologic and ophthalmologic surgery include undergoing a pre-anesthesia assessment in person rather than over the phone, not discharging patients from the hospital unless direct supervision for 24 hours, and contacting the patient by phone 24 hours after discharge to complete a semi-structured interview.[17, 18] In addition to a comprehensive preoperative workup, optimizing their medical condition before non-urgent surgical procedures, planning for a longer hospitalization following surgery, and more scheduling regular postoperative follow-up appointments in the immediate period following the procedure is warranted. Setting realistic expectations for both patients and caregivers is a critical part of the preoperative consent process. Extrapolating these results to ASA IV patients present challenges, since this population was small in the cohort and thus will require further study.

Study limitations include the data size available from ACS-NSQIP, which represents approximately 11% of hospitals in the United States, as well as a larger number of lower ASA Classification patients, that does not necessarily represent the national picture of comorbidity occurrence. To our knowledge, this is the first multi-institutional study observing increased ASA Classification and perioperative risks in hospital-based oral and maxillofacial surgery. It will be important to observe the increasing datapoints that will be available as the ACS-NSQIP database

continues to collect patient information and statistics from hospitals around the United States. Additionally, the procedures included in this study had individually lower statistical power and the investigators were unable to observe an association with perioperative complications, increased operative time, and ASA Classification for specific procedures. Future studies should focus on specific surgical procedures, patient demographics, and hospital course, which will then inform strategies to provide safe and effective surgical care for all patients with hospital-based oral and maxillofacial surgical needs, including ASA III and IV patients.

Conclusion

Nearly half of adults in the United States suffer from at least one chronic medical condition, which includes cancer, diabetes, hypertension, stroke, heart disease, respiratory diseases, arthritis, obesity, and oral diseases.[1] Yet, few reports are available that predict risk and complications in patients undergoing hospital-based maxillofacial surgery. In this study, higher ASA Classification was significantly associated with an increased risk of perioperative complications and longer operative time. Since oral and maxillofacial surgeons are treating more medically compromised patients for both elective and urgent surgical needs, these data support additional measures in ASA III and IV patients. Performing an extensive preoperative evaluation, protracted postoperative monitoring, and discussing a potentially prolonged and complicated hospital course with the patient and family should all be part of the routine protocol. Future studies with large datasets will continue to inform patient care protocols and allow oral and maxillofacial surgeons to safely and effectively treat more medically compromised patients with complex surgical needs.

Statement of Clinical Relevance

With the increased prevalence of medical comorbidities in the United States, it is vital to understand the associated risks and complications involving maxillofacial surgery. This study found increased ASA Physical Status Classification associated with increased operative time and perioperative complications.

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Table 1. Relevant Current Procedural Terminology Codes Identifying Procedures of Interest

Maxillofacial Surgery Category	Current Procedural Terminology Codes
Mandible	21120, 21121, 21122, 21123, 21125, 21127, 21193, 21194, 21195, 21196, 21198, 21199, 21215, 21244, 21247
Maxilla	21141, 21142, 21143, 21145, 21146, 21147, 21206
Midface	21150, 21151, 21154, 21155, 21188, 21208, 21209, 21210
Maxillary/Mandibular	21245, 21246

Table 2. Patient and Hospital Characteristics Stratified by ASA Classification

	ASA I (n=720)	**ASA II (n=757)**	*P-Value (ASA II)*
Body Mass Index, median [IQR]	24.0 [21.5-26.6]	25.8 [22.5-29.9]	<0.001
Age, median [IQR]	24 [21-30]	34 [24-48]	<0.001
Sex (n, %)			0.044
Male	378, 52.5%	375, 49.5%	
Female	342, 47.5%	382, 50.5%	
Race (n, %)			0.02
White	425, 59.0%	502, 66.3%	
Black	49, 6.8%	80, 10.6%	
Asian or PI	77, 10.7%	64, 8.5%	
Other/Unknown	169, 23.5%	111, 14.7%	
Inpatient (n, %)	305, 42.4%	357, 47.2%	0.022
Comorbidities (n, %)			
Hypertension	2, 0.3%	81, 10.7%	0.064
Diabetes	1, 0.1%	20, 2.6%	0.207
Smoker	36, 5.0%	104, 13.7%	0.095
Procedure (n, %)			
Mandibular	311, 43.2%	366, 48.4%	0.32
Maxillary	357, 49.6%	308, 40.7%	0.42
Midjaw	48, 6.7%	72, 9.5%	0.13
Maxillary/Mandibular	4, 0.6%	11, 1.5%	0.04

Table 2 cont. Patient and Hospital Characteristics Stratified by ASA Classification

	ASA III (n=310)	*P-Value (ASA III)*	**ASA IV (n=20)**	*P-Value (ASA IV)*
Body Mass Index, median [IQR]	26.7 [23.0-31.2]	<0.001	27.2 [23.1-32.4]	0.215
Age, median [IQR]	58 [45-67]	<0.001	62.5 [52.5-74.5]	<0.001
Sex (n, %)		0.01		0.81
Male	182, 58.7%		11, 55.0%	
Female	128, 41.3%		9, 45.0%	
Race (n, %)		<0.001		0.747
White	222, 71.6%		12, 60.0%	
Black	34, 11.0%		3, 15.0%	
Asian or PI	20, 6.5%		1, 5.0%	
Other/Unknown	34, 11.0%		4, 20.0%	
Inpatient (n, %)	231, 74.5%	<0.001	16, 80.0%	0.008
Comorbidities (n, %)				
Hypertension	129, 41.6%	<0.001	12, 60.0%	<0.001
Diabetes	33, 10.7%	<0.001	5, 25.0%	<0.001
Smoker	76, 24.5%	<0.001	5, 25.0%	0.08
Procedure (n, %)				
Mandibular	208, 67.1%	<0.001	14, 70.0%	0.07
Maxillary	47, 15.2%	<0.001	3, 15.0%	0.02
Midjaw	30, 9.7%	0.354	1, 5.0%	0.586
Maxillary/Mandibular	25, 8.1%	<0.001	2, 10.0%	0.022

Table 3. Bivariate Comparison of Outcomes Stratified by ASA Classification

	ASA I (n=720)	**ASA II (n=757)**	*P-Value (ASA II)*	**ASA III (n=310)**	*P-Value (ASA III)*	**ASA IV (n=20)**	*P-Value (ASA IV)*
Operative Time, median [IQR]	162 [103.5-235.5]	187 [115-281]	0.92	286 [152-503]	<0.001	412 [156.5-547.5]	<0.001
Length of Stay, median [IQR]	1 [0-1]	1 [0-1.5]	0.001	4 [1-9]	<0.001	7 [1-17]	<0.001
Any Complications, % (n)	19 (2.6)	48 (6.3)	0.005	76 (24.5)	<0.001	11 (55.0)	<0.001
Infectious	15 (2.1)	30 (4.0)	0.321	31 (10.0)	<0.001	6 (30.0)	<0.001
Respiratory	0 (0.0)	5 (0.7)	0.501	6 (1.9)	0.018	4 (20.0)	<0.001
Transfusion	2 (0.3)	13 (1.7)	<0.001	45 (14.5)	<0.001	8 (40.0)	<0.001
Wound	3 (0.4)	4 (0.5)	0.033	11 (3.6)	<0.001	3 (15.0)	<0.001
30-Day Readmissions, % (n)	7 (1.0)	14 (1.9)	0.167	20 (6.5)	<0.001	3 (15.0)	<0.001

Table 4. Multivariate-Adjusted Factors Associated with Operative Time in Maxillofacial Operations

	β-Coefficient *	95% Confidence Interval	P-Value
ASA Classification (ref: No Disturbance)			
Mild Disturbance	7.1	-8.4 to 22.5	0.9
Severe Disturbance	53.2	28.6 to 77.8	< 0.001
Life Threatening	81.5	21 to 141.9	0.008
Weight (ref: Normal)			
Underweight	13.9	-18.8 to 46.7	0.40
Overweight/Obese	1.0	-12.6 to 14.6	0.88
Age	1.1	0.6 to 1.7	< 0.001
Female	-15.0	-28.0 to -1.8	0.03
Inpatient	117.6	103.9 to 131.4	< 0.001
Comorbidities			
Hypertension	8.5	-15 to 32	0.48
Diabetes	-12.1	-49.7 to 25.4	0.53
Smoker	22.3	2.3 to 42.4	0.03
Procedure (ref: Mandibular)			
Maxilla	-5.9	-20.5 to 8.7	0.43
Midface	-16.2	-40.4 to 8	0.19
Maxillary/Mandibular	78.5	38 to 118.9	< 0.001

*β-Coefficient reflects incremental change in operative time (minutes).

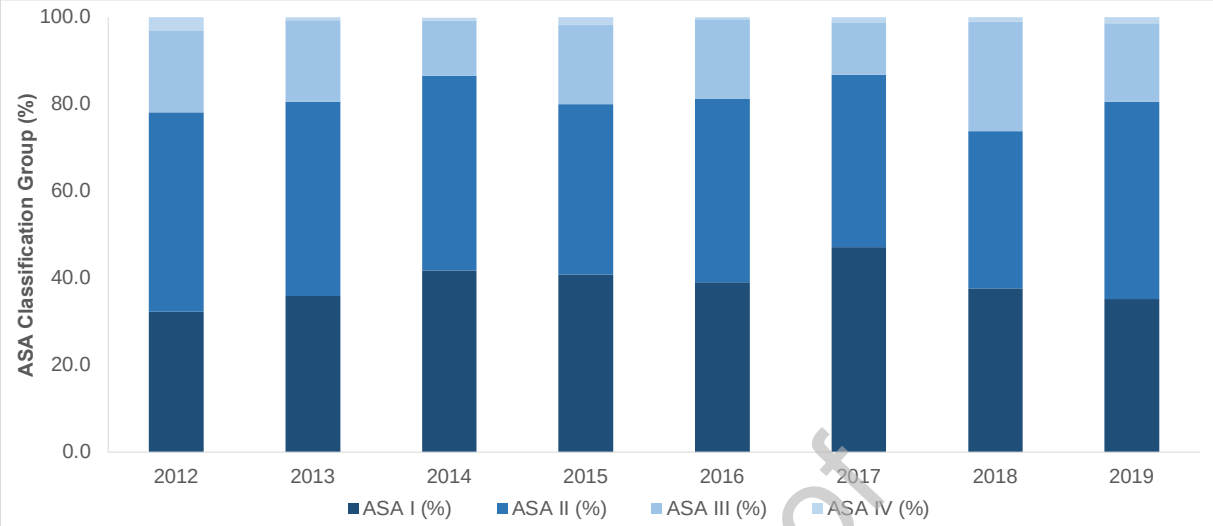

Figure 1 Trends of Included Patient ASA Classification Data Separated by Year