Research Paper
Reconstructive Surgery

Prevalence and predictors of complications following facial reconstruction procedures

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Abstract. Facial reconstruction procedures are immensely challenging and are done for a multitude of reasons. The purpose of this report is to provide nationally representative estimates of different types of facial reconstructive procedures and to examine prevalence and predictors of a wide range of complications associated with these procedures in the USA. The Nationwide Inpatient Sample, the largest inpatient dataset for the USA, was used. Data for the years 2004–2010 related to facial reconstruction procedures were identified through ICD-9-CM procedure codes. Associated complications were identified using secondary diagnosis field codes. Multivariable logistic regression models were used to examine the association between patient/hospital-level factors and the occurrence of complications. A total 26,374 facial reconstruction procedures were performed. About 20% of all patients who had facial reconstruction procedures developed a complication. Frequently occurring complications included postoperative pneumonia (4.9% of hospitalizations), hemorrhage (3.9%), other infections (3.6%), non-healing wounds (3.5%), and iatrogenically induced complications (3.2%). Significant factors found to be consistently associated with different types of complications included age, co-morbid burden, sex, and type of admission. The reported results are generalizable within limitations and can be used by health care providers to tailor quality improvement initiatives to minimize or better treat complications in the high-risk cohorts.

Facial reconstruction procedures are immensely challenging surgical procedures that are performed to replace lost tissue and restore anatomic structures as a result of various diseases and conditions, such as head and neck cancers, benign pathologies, congenital facial anomalies, and maxillofacial trauma.[1,2] As with all surgery, the occurrence of complications is inevitable for these procedures.[3] Complications not only compromise quality of life for the patient, but also increase the cost of health care.[4] Dimick et al. estimated that complications increased costs by at least US $10,000 on average.[5] Therefore it is critical to identify the factors that increase the risks of complications in facial reconstruction procedures. Once identified, risk-mitigating measures can be instituted where feasible. To the authors' knowledge, there are no nationally

representative data on facial reconstruction procedures and associated complications for the USA. The Nationwide Inpatient Sample (NIS) is the largest all-payer, nationally representative, and publically available inpatient health care database in the USA.[6] The NIS dataset is estimated to contain data from more than 36 million hospitalizations nationally. The NIS dataset uses the International Classification of Diseases, Ninth Revision (ICD-9-CM) procedure codes for procedure characterization and collects co-morbidity and adverse events data in the form of reimbursement data using the ICD-9-CM codes.[7] Analyzing this powerful dataset to identify the distribution of procedures and associated complications is a commonly used approach in health care research.[8]

The objective of this report is to provide nationally representative estimates of different types of facial reconstructive procedures and to examine prevalence and predictors of a wide range of associated complications.

Materials and methods

Database description

The NIS for the years 2004–2010 was used.[6] NIS is the largest all-payer, nationally representative inpatient dataset in the USA and provides information on close to 90% of all hospitalizations that occur in the USA. The NIS provides information on the demographic characteristics of patients, reasons for hospitalization, co-morbid burden, procedures performed during hospitalization, and outcomes (such as length of stay in hospital, hospital charges, and disposition status). The present study was granted 'exempt' status by the necessary institutional review board.

Case selection

All hospitalizations during which a facial reconstruction procedure was performed were selected for analysis. ICD-9-CM procedure codes were used to identify the procedures. The procedure codes used included the following: total mandibulectomy with synchronous reconstruction (ICD-9-CM procedure code 76.41), other reconstruction of mandible (76.43), total ostectomy of other facial bone with synchronous reconstruction (76.44), and other reconstruction of other facial bone (76.46).

Outcome variables

The outcomes of interest in the present study included the occurrence of complications during hospitalization. A comprehensive set of complications obtained from prior published studies using nationally representative data were identified using ICD-9-CM codes in the secondary diagnosis fields.[9,10] The complications examined included decubitus ulcers, septicemia, bacterial infections, mycoses, non-healing wounds, hemorrhage, other infections, iatrogenic complications (including pulmonary embolism and infarction, hypotension, pneumothorax, and accidental punctures and lacerations), vascular complications, urinary system complications, digestive system complications, respiratory system complications, nervous system complications, cardiac system complications, and postoperative pneumonia. A composite complication variable termed 'any complication' was also created to examine the occurrence of any of the previously mentioned complications.

Independent variables

A mix of patient-related and hospital-related factors were used as the independent variables in the present study. The patient-related variables included age, sex, race, type of admission, insurance status, co-morbid burden, and primary reason for hospitalization. Co-morbid burden was computed by summing up the individual occurrence of 29 different co-morbid conditions (including AIDS, alcohol abuse, deficiency anemia, rheumatoid arthritis/collagen vascular diseases, chronic blood loss anemia, congestive heart failure, chronic pulmonary disease, coagulopathy, depression, diabetes–uncomplicated, diabetes–with chronic complications, drug abuse, hypertension, liver disease, lymphoma, fluid and electrolyte disorders, metastatic cancer, neurological disorders, obesity, paralysis, peripheral vascular disorders, psychoses, pulmonary circulation disorders, renal failure, solid tumor without metastasis, peptic ulcer disease excluding bleeding, valvular disease, and weight loss). The hospital-related factors included teaching status of the hospital, geographic region of the hospital, and hospital size in terms of the number of beds (hospital bed size: small, medium, or large).

Analytical approach

Simple descriptive statistics were used to summarize the data. Multivariable logistic regression models were used to examine the association between patient/hospital-level factors and the occurrence of complications. A separate model was used for each complication. The effects of clustering of outcomes within hospitals were adjusted. For each level of independent variable, the odds (odds ratio, OR) and associated 95% confidence intervals (95% CI) of developing the different types of complication were computed. All statistical tests were two-sided, and a P-value of <0.05 was deemed to indicate statistical significance. Statistical analyses were conducted using SAS version 9.3 (SAS Institute, Cary, NC, USA) and SUDAAN version 10.0.1 (Research Triangle Institute, Research Triangle Park, NC, USA) software.

Results

During the study period, a total of 26,373 hospitalizations in the entire USA involved facial reconstruction procedures. The mean age of the patients was 42 years. Characteristics of the hospitalizations are summarized in Table 1. The types of facial reconstruction procedure performed included total mandibulectomy with synchronous reconstruction (5.1%), other reconstruction of the mandible (64.9%), total ostectomy of other facial bones with synchronous reconstruction (4.3%), and other reconstruction of other facial bones (27.7%). Each hospitalization could have included more than one procedure. Frequently reported reasons for hospitalization were disorders of the jaw (23.3%), cancer of the head/neck (23.1%), and congenital anomalies (13.2%).

The frequencies of occurrence of the different types of complication are presented in Table 2. Overall, 20.0% of hospitalizations resulted in a complication. The frequently occurring complications included postoperative pneumonia (4.9% of hospitalizations), hemorrhage (3.9%), other infections (3.6%), non-healing wounds (3.5%), and iatrogenically induced complications (3.2%).

The results of the multivariable regression models examining the association between patient/hospital-level factors and the occurrence of complications are summarized in Tables 3 and 4. The significant factors found to be consistently associated with different types of complication included age, sex, race, type of admission, and co-morbid burden. Each 1-year increase in age was associated with higher odds of developing non-healing wounds (OR 1.02, 95% CI 1.01–1.03; $P < 0.05$), cardiac complications (OR 1.04, 95% CI 1.02–1.06; $P < 0.05$), and postoperative pneumonia (OR 1.02, 95% CI 1.01–1.03; $P < 0.05$). When compared