Original Investigation

Revision Rates and Risk Factors of 175 842 Patients Undergoing Septorhinoplasty

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IMPORTANCE Estimates of the rate of revision septorhinoplasty and the risk factors associated with revision are unknown because the current published literature is limited to small, retrospective, single-surgeon studies with limited follow-up time.

OBJECTIVES To determine the rate of revision for septorhinoplasty surgery and to determine the risk factors associated with revision.

DESIGN, SETTING, AND PARTICIPANTS Retrospective cohort analysis of 175 842 patients undergoing septorhinoplasty between January 1, 2005, and December 31, 2009, from the Healthcare Cost and Utilization Project's State Inpatient Databases, State Ambulatory Surgery and Services Databases, and State Emergency Department Databases from California, Florida, and New York. Revisit information for these patients was then collected from the 3 databases between January 1, 2005, and December 31, 2012, with a minimal follow-up time of 3 years; and study analysis done January 1, 2005, to December 31, 2012.

MAIN OUTCOMES AND MEASURES Revision surgery after an index septorhinoplasty was the main outcome measure, and the rate of revision was calculated within subgroups of patients based on different demographic and clinical characteristics. A multivariable model was then used to determine independent risk factors for the performance of revision surgery.

RESULTS The study cohort comprised 175 842 participants who underwent septorhinoplasty procedures; mean (SD) age was 41.0 (15.3) years, and 57.0% were male. The overall revision rate for any septorhinoplasty procedure was 3.3% (5775 of 175 842) (99% CI, 3.2%-3.4%). After separating the patients into primary septorhinoplasty and secondary septorhinoplasty groups, the primary group had an overall revision rate of 3.1% (5389 of 172 324), while the secondary group had an overall revision rate of 11.0% (386 of 3518). Patient characteristics associated with an increased rate of revision include younger age (5.9% [633 of 10 727]), female sex (3.8% [2536 of 67 397]), a history of anxiety (3.9% [168 of 4350]) or autoimmune disease (4.4% [57 of 1286]), and surgery for cosmetic (7.9% [340 of 4289]) or congenital nasal deformities (8.9% [208 of 2334]).

CONCLUSIONS AND RELEVANCE The study results, derived from a large cohort of patients with long follow-up time, suggest that the rate of revision septorhinoplasty is low, but certain patient characteristics are associated with higher revision rates. These data provide valuable preoperative counseling information for patients and physicians. This study also provides robust data for third-party payers or government agencies in an era in which physician performance metrics require valid risk adjustment before being used for reimbursement and quality initiatives.

LEVEL OF EVIDENCE 3.

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In the current facial plastic surgery literature, published rates for revision septorhinoplasty procedures are limited to a small number of retrospective studies,[1-12] often focused on specific surgical techniques from a single institution or single surgeon. Many of these studies[1-11] are also limited by small sample sizes and short duration of follow-up time, making it difficult to draw clinical conclusions. The most generalizable studies[1,5] available in the rhinoplasty literature focus on cosmetic rhinoplasties from surgeons in a single practice or institution, with revision rates of 9.8% and 11%. One single-surgeon, single-institution study[2] published a revision rate of 4% with a sample size of 1524 patients undergoing cosmetic and noncosmetic rhinoplasty. In the literature focusing on specific rhinoplasty techniques, the revision rate varied from 4% to 15.5%.[3,4,7,8] In the septoplasty literature, a large study[9] of 2168 septoplasties by any technique showed a revision rate of 3.2% among experienced surgeons, while studies[10,11] focusing on specific septoplasty techniques showed higher revision rates of 7% to 8%.[9-11] In addition, there may be an underestimation of the revision rates reported in the literature because the authors of single-surgeon or single-institution studies[1-11] review their own respective data and do not include patients who seek revision surgery at another institution, thereby lowering the reported revision rates.

The first objective of this study was to determine the rate of revision septorhinoplasty surgery in a large cohort of patients, covering all practices (multisurgeon) and institutions, over a sufficiently long follow-up period to identify important outcomes. The second objective was to determine the risk factors associated with revision. Identification of factors associated with revision surgery allows for better education among patients and physicians regarding the likelihood of various outcomes in the postoperative period. This study uses large all-payer state databases through the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality, which comprises the largest collection of longitudinal hospital care data in the United States.[12]

Methods

Study Design

This study is a secondary data analysis of a cohort of patients who underwent septorhinoplasty between January 1, 2005, and December 31, 2009, in California, Florida, or New York. The institutional review board of Washington University School of Medicine in St Louis deemed that this study was exempt from oversight by federal definitions of the jurisdiction of the review board.

Data Sources

The HCUP is a group of health care databases and related software tools and products developed through a federal, state, and industry partnership and sponsored by the Agency for Healthcare Research and Quality. This study uses the following 3 HCUP databases: the State Ambulatory Surgery and Services Databases (SASD),[12] the State Inpatient Databases (SID),[13] and the State Emergency Department Databases (SEDD)[14] from California, Florida, and New York. These statewide databases contain information from discharge records for all patients, regardless of age or payer (Medicare, Medicaid, private insurance, or no insurance). Discharge records of inpatient hospital visits are provided through the SID. Records from ambulatory surgery visits at hospitals and freestanding ambulatory surgical centers are provided through the SASD. Records from emergency department visits are provided through the SEDD.

Individual patients are linked and tracked across all 3 databases with an encrypted patient-level identifier. An encrypted variable for the admission date, together with the length of stay, was used to calculate the period between visits for each patient, while keeping the exact dates encrypted to protect patient confidentiality.[12]

Study Population

Patients 13 years or older who underwent septorhinoplasty in an outpatient surgery center between January 1, 2005, and December 31, 2009, in California, Florida, and New York were identified in the SASD using *Current Procedural Terminology* (*CPT*) codes for primary and secondary septorhinoplasty. These codes included 30400, 30410, 30420, 30430, 30435, 30450, 30460, 30462, 30465, and 30520.

The index septorhinoplasty procedure was defined as the first septorhinoplasty surgery for each patient in the SASD between January 1, 2005, and December 31, 2009. In addition, patients were required to be residents of the state in which the procedure was performed to limit loss to follow-up. Revision surgery was defined as any subsequent septorhinoplasty surgery in the database between January 1, 2005, and December 31, 2012. This index group was further divided into patients whose first procedure was a primary septorhinoplasty (*CPT* codes 30400, 30410, 30420, 30460, 30462, 30465, and 30520) and patients whose first procedure was a secondary septorhinoplasty (*CPT* codes 30430, 30435, and 30450). By definition, a patient undergoing a secondary septorhinoplasty is already undergoing revision surgery; therefore, this group was analyzed separately from the primary surgery group to avoid confounding the data. Identified cases in the SASD were then linked by encrypted patient identifier to hospitalizations in the SID and emergency department encounters in the SEDD to obtain information on revision surgery rates contained within these databases.

Outcome Measures

The primary outcome measure was the occurrence of revision septorhinoplasty after an index septorhinoplasty procedure. The *CPT* codes listed as inclusion criteria in **Table 1** were also used to define a revision surgery. The time between the index procedure and the revision procedure was recorded as well.

The secondary analysis examined the association between patient and procedural characteristics and the occurrence of revision surgery. Demographic data were defined at the time of the index procedure. Age was divided into the following 4 groups: 13 to 18 years, 19 to 40 years, 41 to 65 years, and older than 65 years. Race/ethnicity was categorized as

Table 1. *ICD-9* Diagnosis Codes and *CPT* Procedure Codes for Included Data

ICD-9 or *CPT* Code	Description
Inclusion Criteria	
30400	Primary rhinoplasty, lateral and alar cartilages, and/or tip
30410	Primary rhinoplasty, bony pyramid, lateral and alar cartilage, and/or tip
30420	Primary rhinoplasty, bony pyramid, lateral and alar cartilages and/or tip, including major septal repair
30430	Secondary rhinoplasty, minor revision (nasal tip)
30435	Secondary rhinoplasty, intermediate revision (bony work with osteotomies)
30450	Secondary rhinoplasty, major revision (nasal tip and osteotomies)
30460	Cleft rhinoplasty, including columellar lengthening, tip only
30462	Cleft rhinoplasty, including columellar lengthening, tip, septum, and osteotomies
30465	Repair of nasal vestibular stenosis (eg, spreader grafting, lateral nasal wall reconstruction)
30520	Septoplasty or submucous resection with or without cartilage scoring, contouring, replacement with graft
Patient Comorbidities	
305.1, V15.82	Tobacco use
446.4, 135, 733.99, 710.0, G8859, G8860	Autoimmune disease
042, 279.x, 203.x, 204.x, 205.x, 206.x, 207.x, 288.x	Immunodeficiency
295.x, 296.x, 297.x, 298.x, 300.x, 301.x, 303.x, 304.x, 311.x	Psychiatric disorders
Patient Diagnoses	
V50.1	Plastic surgery for unacceptable cosmetic appearance
470	Deviated nasal septum (acquired)
478	Hypertrophy of nasal turbinate
478.19	Nasal airway obstruction or perforation
738	Acquired nasal deformity
748.1	Congenital nasal deformity
754	Congenital nasal or septal deformity
905	Late effect of craniofacial fracture
733.81	Malunion of nasal or septal fixation
959.09	Nose or septum injury
Other Surgical Procedures	
30130, 30140, 30930, 30801, 30802	Inferior turbinate reduction or outfracture
30560	Lysis of synechia
20912	Septal cartilage graft
21210	Bone graft to nose
21230	Rib cartilage graft to nose
21235	Ear cartilage graft to nose
30310, 20670, 20680	Removal of nasal foreign body, deep or superficial implant

Abbreviations: *CPT*, *Current Procedural Terminology*; *ICD-9*, *International Classification of Diseases*, *Ninth Revision*.

white, black, Hispanic, Asian/Pacific Islander, or other. Primary expected payer was divided into the following 5 groups: Medicaid, Medicare, private insurance, self-pay, or other. Patient location was categorized as large metropolitan (≥1 million residents), small metropolitan (<1 million residents), micropolitan (10 000-50 000 residents), or not metropolitan or micropolitan.

Specific comorbidities were examined to determine their possible effect on wound healing, bleeding, or patient expectations listed in Table 1. Most patient comorbidities were defined using the comorbidity measure by Elixhauser et al.[15] This measure contains a group of 30 comorbidities using *International Classification of Diseases*, *Ninth Revision* (*ICD-9*) codes found to be significantly associated with in-hospital mortality. To summarize these comorbidities, van Walraven et al[16] derived and validated an Elixhauser Comorbidity Index that ranges from −19 to 89. The comorbidities were indexed and grouped by quartile to represent the overall patient comorbidity status. Patient diagnoses and additional procedures performed at the time of the index procedure were also assessed and are listed in Table 1.

Statistical Analysis

Standard descriptive statistics were used to describe the study population, and rates of revision surgery after septorhinoplasty within various subgroups were calculated. Univariable logistic regression, applied with a statistical command (PROC SURVEY LOGISTIC in SAS version 9.3; SAS Institute), was used to calculate odds ratios and CIs around the point estimate. Because of the large sample size, the 99% CI was used instead of the 95% CI. Clustering for the hospital identifier was performed to avoid institutional biases. All patient characteristics reaching statistical significance with $\alpha = .01$ in the univariable model were included in a multivariable logistic regression. Diagnostic tests, including tests of multicollinearity, were used to assure that all assumptions of the final model were met. A Kaplan-Meier curve was used to estimate the median time to revision surgery in the study population. Software programs (SAS version 9.3 and SAS Enterprise Guide; both from SAS Institute) were used for all database management and statistical analyses.

Results

Patient Characteristics and Demographics

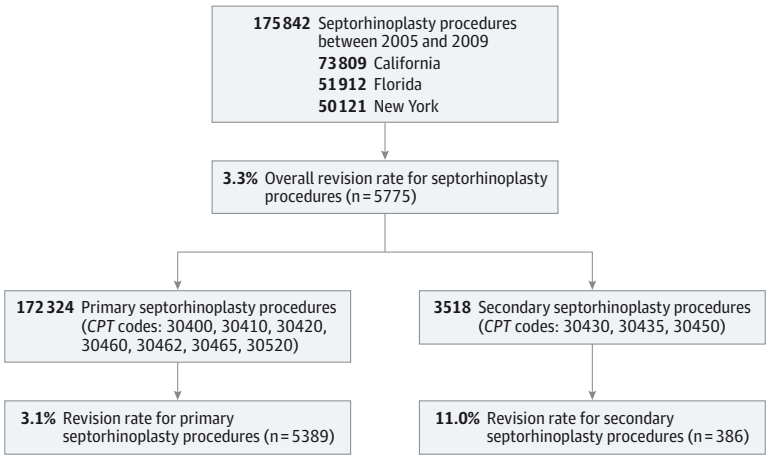
There were 175 842 patients 13 years or older who underwent septorhinoplasty in California, Florida, and New York between January 1, 2005, and December 31, 2009. Of these patients, 172 324 (98.0%) were classified as primary cases, while 3518 (2.0%) were classified as secondary cases (**Figure**). Given the few secondary septorhinoplasty cases, analysis was concentrated further on primary septorhinoplasty cases.

The mean (SD) age of patients undergoing primary septorhinoplasty was 41.0 (15.3) years. Most patients were male (98 283 of 165 580 [59.4%]), and greater majorities defined their race/ethnicity as white (113 975 of 148 368 [76.8%]), had private insurance (130 502 of 172 235 [75.8%]), and were located in large metropolitan areas (122 778 of 172 309 [71.3%]).

Revision Rate and Timing

The overall revision rate for any septorhinoplasty procedure was 3.3% (5775 of 175 842) (99% CI, 3.2%-3.4%). After sepa-

Figure. Study Flow Diagram



CPT indicates *Current Procedural Terminology*.

rating the patients into primary septorhinoplasty and secondary septorhinoplasty groups, the primary group had an overall revision rate of 3.1% (5389 of 172 324), while the secondary group had an overall revision rate of 11.0% (386 of 3518). Of note, 7.1% (384 of 5389) of patients who underwent revision surgery in the primary group had 2 or more revisions. Only 0.4% (770 of 175 842) of patients in the overall cohort underwent 2 or more revisions.

Of patients undergoing revision surgery, the median time to revision was 1.2 years after the index procedure, while 50.0% of patients underwent revision between 8 months and 2.3 years. There was no significant difference in the time to revision surgery between the primary (1.2 years) and secondary (1.1 years) septorhinoplasty groups.

Characteristics of Revision Surgery After Primary Septorhinoplasty

The distribution of demographic and comorbidity characteristics for patients undergoing revision surgery after a primary septorhinoplasty is summarized in **Table 2**. Patients in New York were less likely to undergo revision surgery (2.5%) than patients in California (3.4%) or Florida (3.4%). Patients who were 13 to 18 years old were more likely to undergo revision surgery (5.9%), whereas patients who were 41 to 65 years old (2.6%) or older than 65 years (2.3%) were less likely to undergo revision surgery compared with those who were 19 to 40 years old (3.4%). Female participants (3.8%) were more likely to have revision surgery compared with male participants (2.6%). When comparing race/ethnicity, there was a lower revision rate in blacks (2.1%) and Asians/Pacific Islanders (1.8%) compared with those of white race/ethnicity (3.1%). For insurance status, there was a higher revision rate in patients with self-pay (6.3%) compared with private insurance (2.8%). Finally, patients in small metropolitan (2.8%) or micropolitan (2.1%) areas had a lower revision rate compared with those in large metropolitan areas (3.3%).

When evaluating patient comorbidities, the number of Elixhauser comorbidities did not have a statistically significant effect on the revision rate because most patients fell within the lowest quartile of the Elixhauser Comorbidity Index (169 981 of 172 324 [98.6%]). However, diabetes mellitus (2.4%) and obesity (2.2%) were associated with a decreased revision rate, while anxiety (3.9%) and autoimmune disease or immunodeficiency (4.4%) were associated with an increased revision rate. Alcohol, drug, and tobacco use, as well as coagulopathy, did not show a statistically significant effect on the revision rates.

The revision rates for different patient diagnosis and procedural characteristics were analyzed, and the results are summarized in **Table 3**. Patient diagnoses associated with functional septorhinoplasty had lower rates of revision surgery, including deviated septum (2.7%), turbinate hypertrophy (2.4%), and nasal airway obstruction (2.5%). In contrast, a cosmetic appearance (7.9%) diagnosis code was associated with higher rates of revision surgery, as was a diagnosis of acquired nasal deformity (7.3%). In addition, congenital nasal deformity (8.9%), which is associated with cleft surgery, had a higher rate of revision surgery, as did late effect of craniofacial fracture (5.9%) associated with surgery after facial trauma.

Similarly, procedure codes associated with functional nasal airway surgical procedures had lower revision rates compared with cosmetic or cleft surgical procedures. Septoplasty and inferior turbinate reduction were the most frequently performed surgical procedures and had the lowest revision rates (2.5% and 2.4%, respectively). Repair of vestibular stenosis (6.4%) had a higher rate compared with septoplasty, while primary rhinoplasty procedures had even higher rates of revision, including cartilage or tip repair (8.1%), bony repair (7.3%), and septal repair (7.2%). Cleft rhinoplasty and cleft septorhinoplasty were the least frequently performed surgical procedures and had the highest revision rates (15.4% and 16.9%, respectively). Finally, in evaluating the association between types of nasal grafts and revision surgery, there was a trend in the complexity of graft harvest and nasal repair with an increase in the rate of revision surgery. Septal grafts (6.3%) had the lowest revision surgery rate, followed by bone grafts (11.0%), conchal grafts (11.4%), and rib grafts (21.5%).

Table 2. Demographic and Clinical Characteristics of Revision Surgery After Primary Septorhinoplasty

Characteristic	Total Patients	Patients With Revision Surgery, No. (%)	Unadjusted Odds Ratio (99% CI)
Total	172 324	5389 (3.1)	NA
State			
California	71 854	2419 (3.4)	1 [Reference]
Florida	51 167	1728 (3.4)	1.00 (0.85-1.19)
New York	49 303	1242 (2.5)	0.74 (0.62-0.89)
Age, y			
13-18	10 727	633 (5.9)	1.77 (1.56-2.01)
19-40	72 855	2496 (3.4)	1 [Reference]
41-65	76 268	1977 (2.6)	0.75 (0.68-0.82)
>65	12 474	283 (2.3)	0.65 (0.55-0.78)
Sex[a]			
Male	98 283	2578 (2.6)	1 [Reference]
Female	67 397	2536 (3.8)	1.45 (1.32-1.60)
Race/ethnicity[a]			
White	113 975	3526 (3.1)	1 [Reference]
Black	4126	87 (2.1)	0.68 (0.49-0.93)
Hispanic	17 560	589 (3.4)	1.09 (0.94-1.25)
Asian/Pacific Islander	4467	82 (1.8)	0.59 (0.42-0.82)
Other	8240	260 (3.2)	1.02 (0.83-1.26)
Insurance[a]			
Medicare	16 351	407 (2.5)	0.88 (0.76-1.02)
Medicaid	7010	249 (3.6)	1.27 (1.00-1.60)
Private insurance	130 502	3692 (2.8)	1 [Reference]
Self-pay	10 789	678 (6.3)	2.31 (1.91-2.78)
Other	7583	361 (4.8)	1.72 (1.44-2.05)
Patient location[a]			
Large metropolitan	122 778	4049 (3.3)	1 [Reference]
Small metropolitan	41 323	1160 (2.8)	0.85 (0.74-0.97)
Micropolitan	5858	122 (2.1)	0.62 (0.48-0.82)
Not metropolitan or micropolitan	2350	58 (2.5)	0.74 (0.49-1.13)
Elixhauser Comorbidity Index quartile			
1	169 981	5310 (3.1)	1 [Reference]
2	2340	79 (3.4)	1.08 (0.80-1.46)
3	<10	<10	NA
4	0	0	NA
Patient comorbidities			
Diabetes mellitus	5623	133 (2.4)	0.75 (0.58-0.95)
Obesity	5523	124 (2.2)	0.71 (0.55-0.90)
Alcohol use	1113	41 (3.7)	1.19 (0.81-1.74)
Drug use	948	44 (4.6)	1.51 (0.99-2.32)
Tobacco use	12 553	389 (3.1)	0.96 (0.83-1.11)
Anxiety	4350	168 (3.9)	1.25 (1.02-1.54)
Depression	3620	89 (2.5)	1.06 (0.83-1.37)
Autoimmune disease or immunodeficiency	1286	57 (4.4)	1.44 (1.01-2.07)
Coagulopathy	356	10 (2.8)	0.90 (0.37-2.17)

Abbreviation: NA, not applicable.

[a] Data are incomplete for reporting of sex (6644 [3.9%]), race/ethnicity (23 956 [13.9%]), insurance (89 [0.1%]), and patient location (15 [0.01%]).

The actual revisions performed after the index procedure varied based on the particular original procedure performed. A full analysis of this finding is beyond the scope of this article. However, the most common revision surgical procedures performed in those patients who underwent a primary septoplasty procedure were revision septoplasty (491 of 5099 total revision procedures [9.6%]), inferior turbinate reduction (3197 of 5099 [62.7%]), and repair of vestibular stenosis (446 of 5099 [8.7%]). For those patients who had a primary repair of vestibular stenosis as their index procedure, the most common revision surgical procedures performed were septoplasty (107 of 504 total revision procedures [21.2%]), inferior

Table 3. Diagnosis and Procedural Characteristics of Revision Surgery After Primary Septorhinoplasty

Characteristic	Total No. of Patients	Patients With Revision Surgery, No. (%)	Unadjusted Odds Ratio (99% CI)
Total	172 324	5389 (3.1)	
Patient Diagnoses			
Deviated septum	148 804	3950 (2.7)	0.42 (0.37-0.48)
Turbinate hypertrophy	106 949	2552 (2.4)	0.54 (0.49-0.60)
Nasal airway obstruction	36 287	917 (2.5)	0.76 (0.67-0.87)
Cosmetic appearance	4289	340 (7.9)	2.78 (2.23-3.47)
Acquired nasal deformity	16 132	1178 (7.3)	2.84 (2.47-3.27)
Congenital nasal deformity	2334	208 (8.9)	3.11 (2.43-3.98)
Congenital septal deformity	642	27 (4.2)	1.36 (0.65-2.87)
Late effect of craniofacial fracture	2489	146 (5.9)	1.96 (1.49-2.57)
Procedures Performed			
Septoplasty	150 902	3702 (2.5)	0.29 (0.26-0.33)
Inferior turbinate reduction	113 476	2753 (2.4)	0.53 (0.48-0.59)
Repair of vestibular stenosis	4327	278 (6.4)	2.19 (1.81-2.66)
Primary rhinoplasty			
Cartilage or tip repair	6016	488 (8.1)	2.91 (2.41-3.50)
Bony repair	5305	388 (7.3)	2.56 (2.12-3.09)
Septal repair	11 282	816 (7.2)	2.67 (2.36-3.02)
Cleft rhinoplasty	286	44 (15.4)	5.67 (3.43-9.38)
Cleft septorhinoplasty	349	59 (16.9)	6.36 (4.31-9.38)
Septal graft	4544	286 (6.3)	2.14 (1.81-2.53)
Conchal graft	1319	151 (11.4)	4.09 (3.20-5.23)
Rib graft	195	42 (21.5)	8.56 (5.23-14.01)
Bone graft	227	25 (11.0)	3.86 (1.88-7.93)

turbinate reduction (126 of 504 [25.0%]), and revision repair of the vestibular stenosis (145 of 504 [28.8%]).

Predictors of Revision Surgery

Because multiple demographic, clinical, and procedural factors were found to be associated with revision, a multivariable logistic regression was performed to identify those factors that had an independent effect on revision surgery (**Table 4**). Relative to patients 19 to 40 years old, patients 13 to 18 years old had an increased rate of revision surgery (adjusted odds ratio [aOR], 1.60; 99% CI, 1.40-1.84), whereas there was a decreased rate of revision surgery in patients 41 to 65 years old (aOR, 0.84; 99% CI, 076-0.92) or older than 65 years (aOR, 0.63; 99% CI, 0.48-0.82). Female sex (aOR, 1.11; 99% CI, 1.01-1.22) was associated with a greater likelihood of revision surgery than male sex. Relative to white race/ethnicity, black (aOR, 0.71; 99% CI, 0.52-0.98) and Asian/Pacific Islander (aOR, 0.59; 99% CI, 0.43-0.81) races/ethnicities had lower revision rates. Relative to patients from large metropolitan areas, patients living in micropolitan areas (aOR, 0.74; 99% CI, 0.58-0.96) had a lower rate of revision. Patients with comorbidities of anxiety (aOR, 1.30; 99% CI, 1.03-1.65) or autoimmune disease or immunodeficiency (aOR, 1.52; 99% CI, 1.04-2.21) were also more likely to undergo revision surgery. The following were all independently associated with increased rates of revision: acquired nasal deformity (aOR, 1.42; 99% CI, 1.20-1.68), repair of vestibular stenosis (aOR, 1.86; 99% CI, 1.42-2.45), primary rhinoplasty cartilage or tip repair (aOR, 1.91; 99% CI, 1.50-2.43), primary rhinoplasty bony repair (aOR, 1.63; 99% CI, 1.21-2.19), primary rhinoplasty septal repair (aOR, 1.85; 99% CI, 1.45-2.35), cleft rhinoplasty (aOR, 2.21; 99% CI, 1.19-4.13), cleft septorhinoplasty (aOR, 3.12; 99% CI, 1.86-5.23), conchal graft (aOR, 1.66; 99% CI, 1.28-2.15), and rib graft (aOR, 3.31; 99% CI, 1.84-5.95). Diagnoses and procedures associated with a statistically significant and independent decrease in revision surgery rate include turbinate hypertrophy (aOR, 0.86; 99% CI, 0.76-0.97), nasal airway obstruction (aOR, 0.73; 99% CI, 0.65-0.83), and inferior turbinate reduction (aOR, 0.85; 99% CI, 0.74-0.97).

Discussion

In this study, the overall revision rate in a large cohort of 175 842 patients undergoing septorhinoplasty with a minimal 3-year follow-up period was 3.3%. The rate of revision surgery among primary cases was 3.1%, and that among secondary cases was 11.0%. An increased revision surgery rate was independently associated with age 13 to 18 years, female sex, a history of anxiety or autoimmunity disease or immunodeficiency, acquired nasal deformity, repair of nasal vestibular stenosis, primary rhinoplasty, cleft rhinoplasty or septorhinoplasty, conchal graft, and rib graft. A decreased revision surgery rate was independently associated with age 41 to 65 years and age older than 65 years, black and Asian/Pacific Islander race/ethnicity, micropolitan location, turbinate hypertrophy, nasal airway obstruction, and inferior turbinate reduction. Because these data

Table 4. Multivariable Analysis of Characteristics Associated With Revision Surgery After Primary Septorhinoplasty

Characteristic	Adjusted Odds Ratio (99% CI)
State	
California	1 [Reference]
Florida	1.10 (0.96-1.26)
New York	0.73 (0.63-0.84)
Age, y	
13-18	1.60 (1.40-1.84)
19-40	1 [Reference]
41-65	0.84 (0.76-0.92)
>65	0.63 (0.48-0.82)
Sex	
Male	1 [Reference]
Female	1.11 (1.01-1.22)
Race/ethnicity	
White	1 [Reference]
Black	0.71 (0.52-0.98)
Hispanic	0.98 (0.87-1.12)
Asian/Pacific Islander	0.59 (0.43-0.81)
Other	0.99 (0.82-1.20)
Insurance	
Medicare	1.08 (0.87-1.35)
Medicaid	1.18 (0.94-1.47)
Private insurance	1 [Reference]
Self-pay	0.78 (0.63-0.97)
Other	1.28 (1.06-1.53)
Patient location	
Large metropolitan	1 [Reference]
Small metropolitan	0.88 (0.78-1.00)
Micropolitan	0.74 (0.58-0.96)
Not metropolitan or micropolitan	0.81 (0.54-1.22)
Patient comorbidities	
Diabetes mellitus	1.04 (0.81-1.34)
Obesity	0.80 (0.62-1.02)
Anxiety	1.30 (1.03-1.65)
Autoimmune disease or immunodeficiency	1.52 (1.04-2.21)
Patient diagnoses	
Deviated septum	0.87 (0.75-1.00)
Turbinate hypertrophy	0.86 (0.76-0.97)
Nasal airway obstruction	0.73 (0.65-0.83)
Cosmetic appearance	1.29 (0.98-1.70)
Acquired nasal deformity	1.42 (1.20-1.68)
Congenital nasal deformity	1.21 (0.89-1.65)
Late effect of craniofacial fracture	1.09 (0.81-1.45)
Procedures performed	
Septoplasty	0.86 (0.70-1.06)
Inferior turbinate reduction	0.85 (0.74-0.97)
Repair of vestibular stenosis	1.86 (1.42-2.45)
Primary rhinoplasty	
Cartilage or tip repair	1.91 (1.50-2.43)
Bony repair	1.63 (1.21-2.19)
Septal repair	1.85 (1.45-2.35)
Cleft rhinoplasty	2.21 (1.19-4.13)
Cleft septorhinoplasty	3.12 (1.86-5.23)
Septal graft	0.99 (0.81-1.21)
Conchal graft	1.66 (1.28-2.15)
Rib graft	3.31 (1.84-5.95)
Bone graft	1.71 (0.80-3.65)

are derived from a large data set of patients from 3 different states, multiple surgeons, and various surgical techniques, we believe that these results are generalizable to the entire population of the United States. Furthermore, we believe that these data can be used for important preoperative patient counseling as risk factors and predictors of revision surgery specific to a particular patient.

When the overall study group was divided into primary and secondary septorhinoplasty groups, patients undergoing a secondary rhinoplasty (which by definition is already a revision surgery) were much more likely to undergo a second revision surgery than patients undergoing their first primary procedure. This conclusion is evidenced by the 3.1% revision rate for patients undergoing a primary procedure compared with the 11.0% revision rate in patients undergoing a secondary procedure. In other words, patients who had already experienced one revision surgery were much more likely to undergo another procedure compared with patients who never had prior surgery. However, most multiple revisions (>1 revision surgery) occurred in a small group of patients (770 of 175 842 [0.4%]). These revision rates of 3.1% for primary cases and 11.0% for secondary cases are similar to the rates in published studies[1-8] in the literature for rhinoplasty, which range from 5% for a minor rhinoplasty to 15.5% for a secondary rhinoplasty.

As expected, there was a trend that, as the complexity of the index procedure increased, the rate of revision surgery increased as well. For instance, standard septoplasty had the lowest revision rate of 2.5%. The largest published retrospective study[9] to date of revision septoplasty cases (2168 patients in Scotland) found a similar revision rate between 3.2% and 4.4%. Other studies[10,11] show a slightly higher revision rate between 5% and 8% but again are limited in sample size and follow-up and were conducted at single institutions. Patients undergoing more complex surgical procedures such as cleft septorhinoplasty had a significantly higher revision rate of 16.9%. Similarly, patients who underwent a rib graft (also indicating greater procedural complexity) had the highest revision rate of 21.5% compared with patients who only required a septal graft or conchal graft (6.3% and 11.4%, respectively).

This study provides clinical normative data for the study of surgeon-specific and hospital-specific postprocedural revision surgery rates. In the era of reduced reimbursement rates for physicians and hospitals with lower-than-expected patient outcomes, it is important that insurance companies and government programs must use accurate and relevant data that reflect the current clinical environment in the United States. As an example, the Hospital Readmission Reduction Program of the Patient Protection and Affordable Care Act uses hospital readmissions as a metric of quality care and penalizes hospitals with higher-than-expected readmission rates for patients with certain conditions.[17] While financial penalties do not affect surgical procedures in 2015, penalties are likely to be potential factors in the future. As a result, large multi-institutional normative data sets can assist third-party payers with more accurate standards for revision rates of septorhinoplasty surgery, rather than basing standards on weaker-powered, single-surgeon, retrospective studies with minimal follow-up time. Future investigation by our group will in-

clude analyzing this study cohort for complications and hospital revisit rates 30 days after procedures to also establish a normative standard.

Limitations of this study include the use of an all-payer database, which relies on the accurate recording of *ICD-9* and *CPT* codes by health care professionals and medical record technicians. Incomplete recording can lead to gaps in reporting of specific information such as sex, race/ethnicity, insurance, and patient location, as summarized in Table 2. However, the percentage of missing data was low, except for race/ethnicity, which was as high as 13.9%. Risk factors for revision surgery are likely underrepresented because several *ICD-9* codes for comorbidities tend to be underrecorded in benign outpatient surgical cases. Finally, details of the data are limited to specific billing codes, as evidenced by the inability of the data set to reveal more nuanced causes of revision surgery in most patients. For example, the *CPT* codes 30310, 20670, and 20680 for "removal of nasal foreign bodies or implants" cannot specify what type of implant was removed, which could be valuable prognostic information with respect to alloplastic implants. While we could analyze the specific revision procedures performed, which will help with preoperative counseling, we cannot assume the exact cause of the revision (ie, septal perforation, nasal airway obstruction, etc) because *ICD-9* coding lacks specifics. However, the coding for specific revision procedures gives us at least an accurate assumption of the cause of the revision surgery.

The HCUP databases provide unique and original data that enable extensive opportunities for research into outcomes and quality of care in facial plastic surgery. Future analyses of these databases include assessing the postoperative revisit rates of patients undergoing septorhinoplasty, as well as the risk factors and primary diagnosis associated with these revisits.

Conclusions

These study findings suggest that the overall revision rate for septorhinoplasty ranges from 3.1% to 16.9% depending on various characteristics, particularly the complexity of the underlying surgery. Patient characteristics correlating with an increased rate of revision include younger age, female sex, a history of anxiety or autoimmune disease, and surgery for cosmetic or congenital nasal deformities. These data will provide valuable information in preoperative counseling for patients and physicians regarding patient and procedural characteristics associated with higher rates of revision surgery. Finally, this study will also help provide normative data to third-party payers or government agencies in an era in which physicians could potentially be penalized for revision surgery.

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