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ARTICLE

Cleft lip repair: are outcomes between unilateral and bilateral clefts comparable?

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ABSTRACT

This study sought to compare patient demographics, operative course, and peri-operative outcomes between unilateral and bilateral cleft patients. Primary cleft lip repairs were isolated from the National Surgical Quality Improvement Program Pediatric Database (NSQIP-P). Unilateral and bilateral cases of primary cleft lip were identified by ICD codes. Demographics, comorbidities, and post-operative outcomes were compared between cohorts. Patients were propensity matched to control for differences before repeating the analysis. About 4550 cleft lip repairs were evaluated over the 5-year period. Of the cases where the cleft type was identifiable, 75.5% were unilateral clefts and 24.5% were bilateral clefts. The bilateral cleft population had significantly more comorbidities including higher rates of ventilator dependence (1.0% versus 0.4%, $p = 0.02$), asthma (1.6% versus 0.7%, $p = 0.011$), tracheostomy (1.6% versus 0.5%, $p < 0.001$), gastrointestinal disease (16.9% versus 12.7%, $p < 0.001$), previous cardiac surgery (3.6% versus 2.2%, $p = 0.015$), developmental delay (9.9% versus 4.6%, $p < 0.001$), structural central nervous system abnormalities (5.0% versus 2.5%, $p < 0.001$), and nutritional support (8.0% versus 3.2%, $p < 0.001$). Following propensity matching, there were no significant differences in complications, readmissions, or reoperations between the cohorts. Patients with bilateral cleft lip have significantly more comorbidities than unilateral cleft lip patients. However, peri-operative outcomes are comparable between the groups.

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Introduction

Cleft lip has an incidence of 1:1000 live births with higher incidences among specific ethnic populations or genetic predispositions [1,2]. Distribution of cleft types has been classically described by the 6:3:1 ratio of left:right:bilateral cleft [3–6]. Technical considerations and pitfalls of both unilateral and bilateral cleft lip repair are well described. Possible distinctions in risk factors or early post-operative complications between the two groups have not been as well characterized [7]. Untreated, cleft lip deformity has significant associated psychosocial morbidity and disrupts quality of life [2,6,8–12]. In general though, cleft lip is routinely repaired in infancy with excellent long-term outcomes [13]. Past large single-institutional experiences have evaluated peri-operative outcomes and long-term satisfaction across different cleft types [14]. This national database allows for a more well-powered and cross-sectional analysis.

Prior investigations have defined the typical anatomic deformities of unilateral and bilateral cleft lip with well-described techniques for repair. In regard to these deformities, past studies of unilateral and bilateral cleft lip populations did not identify an impaired microcirculatory flow in the lip and nose or a difference in bite force in the cleft population relative to the non-cleft population. Furthermore, when comparing unilateral and bilateral cleft lip patients, comparable rates of dental anomalies were found [15–17]. Approach to repair and flapping differs between the differing literalities of cleft lip repair [7]. Beyond proper rotation and approximation of skin, vermilion and orbicularis muscle, the mucosal surface also needs to be appropriately lengthened and reapproximated to minimize a foreshortened final lip length [18]. Anatomic differences have been thoroughly defined; however, peri-operative outcomes have been previously reported for cleft lip repair generally. Differences between the unilateral and bilateral cleft lip populations have not been well defined. This study seeks to better define differences between the unilateral and bilateral cleft lip populations and their post-surgical outcomes.

Materials and methods

Exclusion criteria

Utilizing a national pediatric cohort database, five consecutive years of cleft lip repairs were used to compare the unilateral and bilateral cleft lip populations. Data were extracted from the National Surgical Quality Improvement Program Pediatric (NSQIP-P) database between 2012 and 2016. NSQIP-P collects outcomes from over 100 hospitals in the United States and includes over 200 variables including demographics, comorbidities, complications, and outcomes [19]. As an example, the ACS NSQIP guide states: "YES' is entered if the patient's medical record documentation states the patient is not appropriate for developmental age … Developmental status and/or cognitive ability impairment is defined when a child does not reach his/her developmental milestones at the expected times. It is an ongoing delay in the process of development."

Cases of Primary Cleft Lip were isolated by using the CPT codes 40700, 40701, and 40702. All patients over the age of 3 years were excluded from the sample. Patients with bilateral cleft lip were identified by the ICD9 code (749.03, 749.04, 749.13, 749.14, 749.23, and 749.24) and the ICD10 code (Q36.0, Q37.0, Q37.2, Q37.4, and Q37.8). Patients with unilateral cleft lip were identified by the ICD9 code (749.01, 749.02, 749.11, 749.12,

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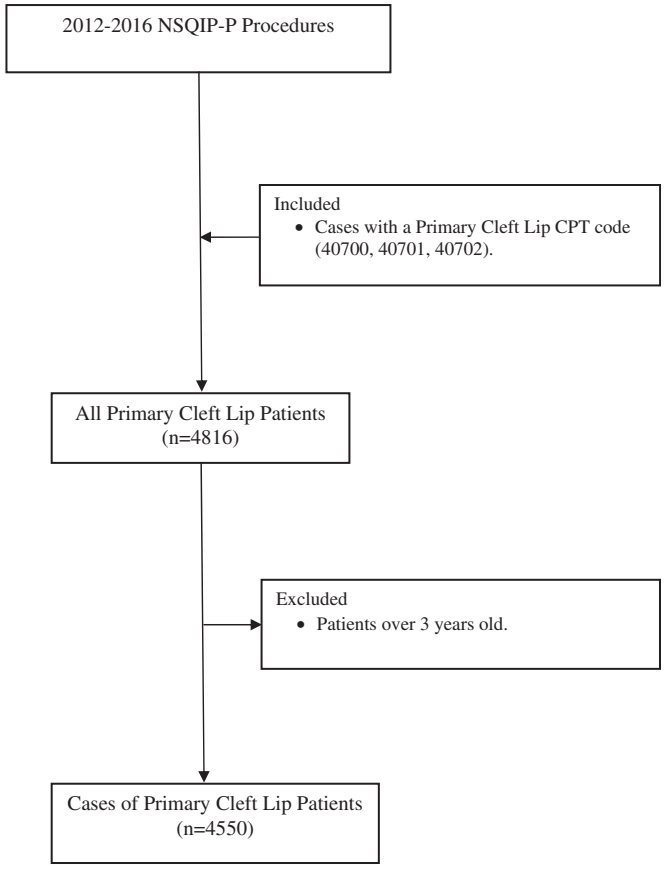

Figure 1. Study population.

749.21, and 749.22) and the ICD10 code (Q36.9, Q37.1, Q37.3, Q37.5, and Q37.9).

Statistical analysis

Patient demographics were analyzed using basic frequency demographics. Unilateral and bilateral cleft lip patients were compared using Chi-squared and Fisher's exact tests for categorical variables. Continuous variables were compared using *t*-tests. Patients in the unilateral and bilateral cleft groups were then propensity matched based on significant comorbidities, surgical specialty, age, race, gender, and ASA (caliper set to 0.01). ASA is a measure of risk that takes into account patient comorbidities, physiologic reserve, and overall health [20]. This propensity matched population was then analyzed using Chi-squared and Fisher's exact tests for categorical variables and *t*-tests for continuous variables.

Results

Sample demographics

About 4550 cleft lip repairs were identified over 5 years (Figure 1). The majority of patients were male (63.1%) and white (69.3%), and the majority of clefts were unilateral (75.5%). Plastic surgery predominantly performs repairs (85.0%) at a mean age of 180.5 ± 148.3 days. The mean operative time was 123.8 ± 62.1 min (Table 1).

Unilateral *versus* bilateral cleft lip analysis

Of the cases where the cleft type was identifiable, 2814 were unilateral clefts (75.5%) and 911 (24.5%) were bilateral clefts. The unilateral population was more likely to be female (37.3% versus 33.5%, $p = .038$). There were no significant differences between unilateral and bilateral cleft lip patients in terms of race or surgical specialty. Unilateral cleft lips were repaired at older ages than bilateral cleft lips (198.8 d versus 168.3 d, $p < .001$) and were longer surgeries (146.5 min versus 116.8 min, $p < .001$).

Table 1. Primary cleft lip demographics.

Demographic	*n* (%)	*n* (SD)
N (number of patients)		4550
Female, *n* (%)	1680 (36.9)	
Race, *n* (%)		
White	3152 (69.3)	
Black	390 (8.6)	
Asian	269 (5.9)	
Other	769 (16.3)	
Surgical specialty, *n* (%)		
Plastic surgery	3869 (85.0)	
Otolaryngology	628 (13.8)	
Other	53 (1.1)	
Cleft type, *n* (%)		
Unilateral	2814 (75.5)	
Bilateral	911 (24.5)	
Age (days)		180.5 (148.3)
Operation time (min)		123.8 (62.1)
Total length of stay (days)		1.0 (8.3)

The bilateral cleft lip population had significantly more comorbidities including higher rates of ventilator dependence (1.0% versus 0.4%, $p = .02$), asthma (1.6% versus 0.7%, $p = .011$), tracheostomy (1.6% versus 0.5%, $p < .001$), gastrointestinal disease (16.9% versus 12.7%, $p < .001$), previous cardiac surgery (3.6% versus 2.2%, $p = .015$), developmental delay (9.9% versus 4.6%, $p < .001$), structural central nervous system abnormalities (5.0% versus 2.5%, $p < .001$), and nutritional support (8.0% versus 3.2%, $p < .001$). Bilateral cleft lip patients had a significantly higher proportion of patients with ASA classes 2 and 3 than unilateral cleft lip patients ($p < .001$) (Table 2).

Peri-operative complications between unilateral and bilateral cleft lip patients were comparable except for higher rates of bleeding (0.4% versus 0.0%, $p = .004$) and hospital stays over 30 d (0.7% versus 0.1%, $p = .009$) among bilateral cleft lip patients. There were no other significant differences in complications, readmission rate, or reoperation rate (Table 3).

Propensity matched unilateral *versus* bilateral cleft lip analysis

Unilateral and bilateral cleft lip patients were propensity matched by comorbidities, surgical specialty, age, race, gender, and ASA. Then, outcomes between 855 unilateral and 855 bilateral cleft lip patients were compared. There were no significant differences for any complications, readmissions, or reoperations between the two populations (Table 4).

Discussion

In an analysis of over 4500 cleft lip repairs, we were able to compare patient profiles and peri-operative outcomes between unilateral and bilateral cleft lip patients [1,2]. Although bilateral clefts have been thought to traditionally constitute 10% of all cleft patients, in our cohort bilateral cases represented a quarter of the patients [3]. Ratios of cleft types for surgical patients may differ from the incidence of cleft types for new births. Additionally, the bilateral cleft population may include patients adopted to the United States, which have higher proportions of bilateral clefts [21].

Surprisingly, bilateral cleft lip patients in the United States have significantly more comorbidities with respect to pulmonary,

Table 2. Unilateral versus bilateral primary cleft lip demographics.

Demographic	Unilateral	Bilateral	*p*-Value
N (number of patients)	2814	911	
Female, *n* (%)	1049 (37.3)	305 (33.5)	**.038**
Race, *n* (%)			.851
White	1956 (69.5)	634 (69.6)	
Black	239 (8.5)	79 (8.7)	
Asian	163 (5.8)	58 (6.4)	
Other	456 (16.2)	140 (15.4)	
Surgical specialty (%)			.106
Plastic surgery	2394 (85.1)	774 (84.9)	
Otolaryngology	386 (13.7)	134 (14.7)	
Other	34 (1.2)	4 (0.4)	
Comorbidities, *n* (%)			
Ventilator dependence	10 (0.4)	9 (1.0)	**.02**
History of asthma	20 (0.7)	15 (1.6)	**.011**
Chronic lung disease	27 (1.0)	16 (1.8)	**.05**
Oxygen support	20 (0.7)	12 (1.3)	.085
Tracheostomy	13 (0.5)	15 (1.6)	**<.001**
Airway abnormalities	104 (3.7)	39 (4.3)	.424
Gastrointestinal disease	357 (12.7)	154 (16.9)	**<.001**
Previous cardiac surgery	61 (2.2)	33 (3.6)	**.015**
Developmental delay	130 (4.6)	90 (9.9)	**<.001**
Seizure disorder	22 (0.8)	12 (1.3)	.14
Cerebral palsy	0 (0.0)	1 (0.1)	.245
Structural CNS abnormality	69 (2.5)	46 (5.0)	**<.001**
Neuromuscular disorder	20 (0.7)	12 (1.3)	.085
Steroid use (within 30 d)	8 (0.3)	5 (0.5)	.239
Open wound	3 (0.1)	1 (0.1)	.999
Nutritional support	90 (3.2)	73 (8.0)	**<.001**
Hematologic disorder	17 (0.6)	8 (0.9)	.379
Inotropic support	2 (0.1)	0 (0.0)	.999
ASA classification, *n* (%)			**<.001**
1	1047 (37.2)	195 (21.4)	
2	1524 (54.2)	593 (65.1)	
3	226 (8.0)	114 (12.5)	
4	13 (0.5)	9 (1.0)	
5	0 (0.0)	0 (0.0)	
Age (days)	168.3 (137.9)	198.8 (154.3)	**<.001**
Operation Time (minutes)	116.8 (57.4)	146.5 (71.0)	**<.001**
Total Length of Stay (days)	1.0 (7.5)	1.0 (8.6)	.843

*ASA Classification is a pre-operative risk scale for patient physiologic stability created by the American Society of Anesthesiologists.
Bold values are $p < 0.01$.

Table 3. Unilateral versus bilateral cleft lip peri-operative complication profile.

Complication	Unilateral	Bilateral	*p*-Value
N (number of patients)	2814	911	
Complications, *n* (%)			
In hospital >30 d	3 (0.1)	6 (0.7)	**.009**
Death in 30 d	3 (0.1)	0 (0.0)	.773
Superficial incisional SSI	9 (0.3)	7 (0.8)	.072
Deep incisional SSI	3 (0.1)	1 (0.1)	.980
Organ SSI	1 (0.0)	0 (0.0)	.999
Deep wound dehiscence	6 (0.2)	4 (0.4)	.272
Pneumonia	4 (0.1)	3 (0.3)	.372
Unplanned intubation	8 (0.3)	6 (0.7)	.121
Pulmonary embolism	0 (0.0)	0 (0.0)	.999
Renal insufficiency	0 (0.0)	0 (0.0)	.999
Renal failure	0 (0.0)	0 (0.0)	.999
Urinary tract infection	5 (0.2)	3 (0.3)	.414
Coma	0 (0.0)	0 (0.0)	.999
CVA/stroke	1 (0.0)	0 (0.0)	.999
Seizure disorder	3 (0.1)	2 (0.2)	.418
Nerve injury	0 (0.0)	0 (0.0)	.999
Intraventricular hemorrhage	0 (0.0)	0 (0.0)	.999
Cardiac arrest	2 (0.1)	1 (0.1)	.597
Bleeding	0 (0.0)	4 (0.4)	**.004**
Flap failure	0 (0.0)	0 (0.0)	.999
Sepsis	2 (0.1)	0 (0.0)	.999
Readmission, *n* (%)	105 (3.7)	35 (3.8)	.879
Reoperation, *n* (%)	22 (0.8)	12 (1.3)	.140

*SSI is an abbreviation for surgical site infection.
Bold values are $p < 0.01$.

Table 4. Unilateral versus bilateral cleft lip propensity matched comparison of complications.

Complication	Non-readmission	Readmission	*p*-Value
N (number of patients)	855	855	
Complications, *n* (%)			
In hospital >30 days	0 (0.0)	3 (0.4)	.250
Death in 30 days	1 (0.1)	0 (0.0)	.999
Superficial incisional SSI	3 (0.4)	6 (0.7)	.507
Deep incisional SSI	0 (0.0)	1 (0.1)	.999
Organ SSI	0 (0.0)	0 (0.0)	.999
Deep wound dehiscence	3 (0.4)	3 (0.4)	.999
Pneumonia	0 (0.0)	3 (0.4)	.250
Unplanned intubation	1 (0.1)	4 (0.5)	.374
Pulmonary embolism	0 (0.0)	0 (0.0)	.999
Renal insufficiency	0 (0.0)	0 (0.0)	.999
Renal failure	0 (0.0)	0 (0.0)	.999
Urinary tract infection	0 (0.0)	1 (0.1)	.999
Coma	0 (0.0)	0 (0.0)	.999
CVA/stroke	0 (0.0)	0 (0.0)	.999
Seizure disorder	0 (0.0)	0 (0.0)	.999
Nerve injury	0 (0.0)	0 (0.0)	.999
Intraventricular hemorrhage	0 (0.0)	0 (0.0)	.999
Cardiac arrest	0 (0.0)	0 (0.0)	.999
Bleeding	0 (0.0)	4 (0.5)	.125
Flap failure	0 (0.0)	0 (0.0)	.999
Sepsis	1 (0.1)	0 (0.0)	.999
Readmission, *n* (%)	37 (4.3)	28 (3.3)	.255
Reoperation, *n* (%)	5 (0.6)	10 (1.2)	.300

*SSI is an abbreviation for surgical site infection.
Bold values are $p < 0.01$.

gastrointestinal, neurologic, and cardiac disease. Isolated cleft palate patients are known to have higher rates of underlying systemic disease, but comparative differences between unilateral and bilateral cleft lip patients have not been shown [22].

Encouragingly, despite significantly more pre-operative comorbidities, bilateral cleft lip patients had comparable peri-operative complications than unilateral cleft lip patients. Systemic comorbidities are associated with prolonged length of stay, readmission, and reoperation rates for other surgical procedures [23,24]. However, in our analysis, only increased bleeding and prolonged hospital stay were identified in bilateral cleft lip repairs. Once propensity matching for comorbidities, age, BMI, ASA, and surgical specialty was performed, there were no significant differences between the unilateral and bilateral cleft populations.

Prior studies have found a low overall complication profile for cleft lip repair with less than 5% of patients having any complication [25–28]. Comparisons between cleft lip type have been in small case series [29]. Previous single institution studies although small, have shown an association between increased comorbidities and complication rates [30]. Since comorbidities are linked to higher complication rates, *a priori* bilateral cleft lip patients would be expected to have higher complication profiles [31]. Low rates of post-surgical complications following all cleft lip repair surgery may minimize any increased risk among a more susceptible patient population.

Limitations of this study relate to the NSQIP-P database as it lacks cleft specific post-operative complication variables, do not control a surgeon, and, in some cases, could not differentiate between unilateral versus bilateral leading to some loss of power and potentially skewed cohort ratios of unilateral to bilateral clefts. Additionally, only 30-d post-operative outcomes were available. Long-term outcomes specific to cleft lip such as history of lip revision, presence of an alveolar fistula/need for alveolar bone grafting, and the suboptimal aesthetic result could not be obtained from this database. Also, the use of CPT coding prevented differentiation between cleft lip adhesion versus cleft lip repair. Some cases labeled as cleft lip repair may have actually been adhesions, which would impact recorded operative time.

Overall, the bilateral cleft lip population in the United States has significantly more comorbidities at baseline than unilateral cleft lip patients. Despite the differences in patient characteristics, peri-operative outcomes are comparable between the two groups. The bilateral cleft lip patients have similar peri-operative outcomes to the unilateral population.

NSQIP disclosure

The American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

Author contributions

Fouad Chouairi, B.S.: Study Design, Data Collection, Statistical Analysis, Tables, Manuscript Preparation and Revisions

Elbert J Mets, B.A.: Study Design, Data Collection & Analysis, Manuscript Preparation and Revisions

Sina J Torabi, B.A.: Study Design, Tables, Manuscript Preparation and Revisions

Michael Alperovich, M.D., M.Sc.: Principle Investigator, Study Design, Tables, Manuscript Preparation and Revisions.

Disclosure statement

No potential conflict of interest was reported by the authors.

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