Published in final edited form as:

Clin Pediatr (Phila). 2013 August ; 52(8): 699–706. doi:10.1177/0009922813492878.

Trends in Revision Circumcision at Pediatric Hospitals

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Abstract

Background—We sought to determine the incidence of revision circumcision at free-standing children's hospitals, and examine trends over time.

Methods—We searched the Pediatric Health Information Systems (PHIS) database to identify boys undergoing (revision circumcision (RC), primary non-newborn circumcision (PC) or lysis of penile adhesions (LPA)) from 2004–2009. Rates of RC procedures were calculated by dividing the incidence of procedures by the total male ambulatory surgical volume.

Results—We identified 34,568 patients of whom 5,632 underwent RC, 25,768 PC, and 3,168 LPA. The rate of RC increased 119%; significantly more than PC (19%; $p < .001$) or LPA (37%; $p < .001$). Urologists performed 76% of RC and 12% were performed in with other genitourinary procedures. Boys undergoing RC were predominately white (60%) and publicly insured (61%).

Conclusions—There was a disproportionate increased rate of RC performed at PHIS hospitals compared to PC or LPA. Wide variation exists in rate increases among hospitals.

INTRODUCTION

Circumcision is the most common surgical procedure performed on boys worldwide.¹ In the United States, the incidence of newborn circumcision (NC) has been estimated to be 57–61%.^{2, 3} Although circumcision is an elective procedure often done for cultural or religious reasons, several health benefits are recognized⁴ and are supported by recent large randomized trials.^{5–7} While surgical complication rates are low (0.2–16%,^{8, 9} with most estimates at 1–2%⁹) concerns about the cosmetic outcome (skin adhesions, hidden penis, redundant residual tissue) may prompt revision circumcision (RC) in up to 10% of cases.^{10, 11} There are few data available regarding either family satisfaction with NC outcomes or rates of RC. Since the need for subsequent revision may be related to the adequacy of NC,^{12, 13} rates of RC may serve as an indicator of the quality of NC. The aim of

this study was to describe trends over time in the incidence of RC in United States children's hospitals, and to examine factors associated with RC.

PATIENTS AND METHODS

Data Source

We queried the Pediatric Health Information System (PHIS), a national administrative and billing database from freestanding children's hospitals affiliated with the Child Health Corporation of America (Shawnee Mission, KS). PHIS is composed of over 1,000,000 pediatric patient encounters annually, including data from inpatient admissions, ambulatory medical and/or surgical short-stay areas, and emergency department visits. PHIS data accuracy is jointly screened on a quarterly basis by the Child Health Corporation of America, an independent data manager (Thomson Healthcare, Durham, NC), and by each participating hospital. Data are accepted into PHIS only when classified errors occur in less than 2% of a hospital's quarterly data. For this study, we included data only from those hospitals that contributed data on all inpatient, ambulatory surgery, and short-stay visits for a given quarter; hospitals that contributed only partial data (*e.g.*, inpatient visits only) were excluded during that period. Data from 28 hospitals were included in this study including 13 hospitals contributing data for the entire study period.

Patient Population

We identified all hospital encounters occurring between January 2004 and December 2009 for patients 18 years of age or less with Current Procedural Terminology (CPT) procedure code 54163 (revision of incomplete circumcision). For comparison purposes, we also identified all patients undergoing non-newborn surgical primary circumcision (PC, CPT 54161), and lysis of post-circumcision penile adhesions (LPA, CPT 54162). We excluded those patients with two or more of the above codes, as well as patients undergoing RC, PC, or LPA as part of a more complex penile procedure including hypospadias/urethral repair, chordee correction or other penile procedures (biopsies, plastic procedures and removal of penile lesions). Boys undergoing concurrent frenulotomy were included ($n=19$).

Variable Selection

The primary outcome was the hospital-specific incidence of RC, defined as the ratio of the number of RC to the total male ambulatory surgical volume at that hospital, assessed quarterly, from 2004 through 2009. Because the CPT code for RC was introduced in 2002,¹⁴ increases in usage of this code in subsequent years may have been due in part to the adoption of a new code. We therefore specifically included LPA (the CPT code for which was also introduced in 2002) as a control for incremental adoption of a new code.

We identified other (non-penile) surgical procedures performed concomitantly to examine for convenience as an explanatory factor. These other procedures were grouped into the following categories: hernia/hydrocele, orchidopexy, varicocele, other scrotal surgery, GU endoscopy, other GU procedures, umbilical hernia, tympanostomy, and other non-GU procedures. Insurance status was defined as public or private payer. Demographic data were collected, including self-reported race/ethnicity (white, black, Latino or other), and these

were compared to the entire cohort of male ambulatory surgery patients at the included PHIS hospitals.

Approximate resource costs were derived from hospital billing records, adjusted by the CMS wage/price index for the hospital's location and the ratio of charge to cost. These adjusted cost estimates closely approximate the hospital level resource consumption for these services (as opposed to hospital charges, which do not).¹⁵ Mean and median costs for RC were determined from encounters where RC was the only procedure performed. PHIS data include hospital charges only; physician reimbursements are not captured.

Statistical Methods

We compared the change in incidence of RC to that of PC and LPA over time using Poisson regression. RC incidence rate was defined as the number of cases of a given procedure during a given quarter, divided by the total male ambulatory surgery volume for that quarter. General linear mixed models with hospital as a repeated subject and the study quarter as a random effect variable were used to account for hospital-level clustering. In addition, demographic trends were tested using Mantel-Haenszel chi-square trend (χ^2 -trend) or analysis of variance (ANOVA) based on data characteristics. All analyses were performed using SAS version 9.2 (SAS Institute Inc., Cary, NC). All tests were two-sided and p-values of less than 0.05 were considered significant.

Institutional review board approval was obtained from Children's Hospital Boston and administrative approval was obtained from the PHIS administrator prior to data collection and analysis.

RESULTS

Study Population

We identified 39,813 male surgeries at PHIS hospitals with CPT codes for RC, PC, or LPA between January 2004 and December 2009. We excluded 13% of the sample (5,245/39,813 for simultaneous penile procedures as described above) leaving 34,568 for analysis, of whom 5,632 underwent RC, 25,768 underwent PC, and 3,168 underwent LPA. During the same period, there were a total of 676,369 male ambulatory surgical procedures at the included hospitals.

The mean (SD) age of boys undergoing RC was 2.5 ($\pm$ 2.8) years (Table 1) and did not significantly change from year to year ($p=0.35$). Boys undergoing RC were predominantly white (60%) and publicly insured (62%). The race and insurance status of boys undergoing RC did not show any significant trends over the course of the study period (χ^2 -trend $p=0.72$ and $p=0.13$ respectively). Of all male ambulatory surgeries, 67% were white and 59% had public insurance ($p<0.01$).

Trends in RC

The total number of RC procedures in 2004 was 413 and increased annually to a total of 1,436 in 2009. The ratio of RC to total male ambulatory surgical procedures increased by 119% from 2004 to 2009. (Figure 1) The change in relative rate over time was significantly

higher than increases in PC ($p<0.001$) or LPA ($p<0.001$) over the same time period. Rate increases were seen in all geographic regions (Figure 2). After using a mixed-effects model to account for hospital-level clustering, the differential rate increase for RC remained significantly higher than PC or LPA ($p<0.001$ for each). This suggests that the increases we report were not driven solely by a small subset of hospitals.

Among the 13 hospitals that contributed data for all quarters between 2004 and 2009 ($n=13$), there was significant variation in the overall change in rate of RC ($p<0.001$) (Figure 3), ranging from an increase of 1100% to a 36% reduction. All but 3 of the 13 hospitals saw an increase in rate of RC during the study period, and 6 hospitals (46%) saw increases over 100%.

Simultaneous Additional Procedures

RC was performed concurrently with other procedures 24% of the time, and half of these were other GU procedures. The most common genitourinary procedure performed concurrently with RC was hernia/hydrocele repair, followed by orchidopexy, although non-genitourinary procedures were the most common overall (Table 2). Urologists were more likely than pediatric surgeons to perform RC or PC as stand alone procedures (RC; 77% vs 73% $p<0.01$, PC; 81% vs 73% $p<0.01$). The proportion of RC performed with additional procedures did not change over time ($p=0.64$).

Costs

The median adjusted hospital cost for boys that underwent RC as a solitary procedure was \$1,554 (interquartile range \$1,156 – \$1,944). The average annual cost at a given hospital for RC performed as a solitary procedure was \$57,854 for a total of \$6,884,631 from 2004 to 2009 at the 28 PHIS hospitals. These figures do not include time costs for families nor physician costs.

DISCUSSION

In this study, we found that the rate of RC at PHIS hospitals, as a function of total surgical volume, increased by 119% from 2004 to 2009. There are several possible explanations for a rise in the incidence of RC: 1) increased RC may be due to a rise in the number of NC and PC (with resulting increases in absolute number of patients needing revision, even if the proportion needing revision remains constant), 2) an increase in the number of unsatisfactory outcomes after NC and PC (with resulting increases in the number needing revision) or 3) changing standards of satisfaction after NC and PC (with resulting increases in number of families desiring revision) despite a relatively stable number of typical-quality primary circumcisions.

The first possibility is that more NC or PC are being performed. Only boys who have had a prior circumcision are candidates for RC, so if the source population has grown, this could explain the increased rate of RC. Although some studies using national data have demonstrated an increase in newborn circumcision rates in recent years², other data have shown that the rate is largely flat (55–65% nationally) or even decreasing.^{3, 16, 17} The estimated number of live births in the U.S. increased 3% from 4,054,623 in 2004 to

4,186,618 in 2009.¹⁸ In light of these figures, it is highly improbable that an increase in RC of the magnitude we observed (>100%) could be due entirely to increases in the total number of boys being circumcised.

Another explanation for increasing RC is that there has been a change in the quality of primary circumcisions, with the result that a higher proportion of individuals have unsatisfactory outcomes requiring revision. There is wide variation in the credentials, training, and experience of clinicians who perform NC; the procedure can be technically challenging and there is a natural tendency to err on the side of caution to minimize risk of penile injury. One study suggested that training in neonatal circumcision during general pediatric residency training was insufficient.¹⁹ Another found significant variation in NC training among residency programs and while most family practice and obstetric programs teach NC, a majority of surveyed pediatric programs do not.^{20, 21} Trainee experience with NC varies by institution and region, along with varying community practices and customs. Pediatric residents who train in a community where the obstetricians perform most newborn circumcisions may not be exposed to these procedures, and vice-versa. All of this variability in the practice of newborn circumcision could be associated with variations in quality that lead to an increase in need for revision. However, we are unaware of any empiric data that suggest that NC outcomes have changed significantly (for better or worse) over the past 20 years.

Lastly, it may be that parental or clinician standards for penile appearance post-circumcision have evolved. Community standards regarding what a ‘properly’ circumcised penis looks like may be changing, with families less likely to accept any redundant tissue and more motivated to pursue revision. Such trends would be difficult to measure and impossible to detect in our data.

We considered the possibility that RC is being performed more frequently as an adjunct procedure when a boy is already in the operating room for something else. In such circumstances, families might be willing to consider a penile “touch-up” for a problem that they might not otherwise be interested in pursuing as a stand-alone procedure. However, most RC procedures (76%) are not being performed concurrently with other procedures. Furthermore, we found no change in the proportion of RC performed with other procedures over time.

A majority of boys undergoing RC in our sample were publicly insured (62%) which was similar to proportion observed in the total ambulatory surgical cohort. Interestingly, insurance status is an important determinant of NC; newborns with private insurance are more likely to undergo neonatal circumcision than those with public or no insurance (64% versus 41–43% respectively)² and boys born in states where NC is not covered by Medicaid are less likely to be circumcised than those born in states where the procedure is covered.²² However, this does little to explain the rise in RC in our data since the public/private insurance mix did not change from 2004 to 2009 among those undergoing RC or those in the ambulatory surgical cohort.

The increasing trends in RC are not unique to a single geographic region. While there is some variation in the increase of RC across geographic regions, this may reflect local differences such as varied adoption of the new CPT code, or local quality factors leading to different baseline 2004 numbers. A large proportion of our sample was derived from the South and Midwest regions where the baseline (2004) rates of RC were higher than average (Figure 2). However, the fact that increasing rates of RC are found in all regions suggests that causative factors could be present at a national level.

RC is expensive relative to NC because of the need for general anesthesia and an operative suite. The cost of primary circumcision in older boys is higher than in newborns by a factor of ten.²³ The median cost of an operative RC at the 28 children's hospitals in our sample was \$1,554, similar to those reported by others.¹⁰ The total cost attributed to RC at PHIS hospitals during the study period was between \$7 million and \$9 million. These costs do not include surgeon reimbursement or any productivity losses for parents/caregivers during their child's recovery. Furthermore, since these costs are estimated based on resource use, the "price tag" for third party payers can be twice as much.¹⁵

This study's results should be interpreted in light of its limitations. The PHIS database is derived from tertiary-care, freestanding children's hospitals, and our patient population may not be typical of patients or treatment patterns seen at other hospital types. As such, it is unclear whether our results are generalizable to the wider community. Furthermore, we cannot determine the true denominator: the underlying number of boys who are 'at risk' for undergoing revision circumcision. We worked around this limitation by comparing the number of RC's to the total number of ambulatory cases; if RC is stable as a proportion of total surgical volume, this implies that the relative rate of RC is largely unchanged over time. Also, because it is not possible to determine how many boys undergo neonatal circumcision in the community, we cannot be certain that the relatively stable rate of PC seen in our data correlates with the actual number of circumcisions performed in the region serviced by the corresponding hospitals. In addition, there could be shifts in local treatment patterns such that more RC are being performed in tertiary centers than in the past, with resulting increases in RC rates. However, we believe that it is unlikely that such shifts in market share would lead to the dramatic increases seen in our sample, in all regions of the country. Lastly, our analysis relies on the accuracy of the diagnostic and procedure codes included in PHIS; while the accuracy level of PHIS is high for an administrative database, it is possible at least some portion of our cohort may be incorrectly coded. This is especially true since the code for RC was not available until 2002. It could also be possible that trends in the choice of codes used may have affected our results. We have attempted to mitigate these effects by selecting 2004 as the starting year and concurrently examined LPA rates as a measure of new code usage; however, this adjustment may not fully account for the effects of the coding changes.

CONCLUSIONS

The number of revision circumcisions performed at children's hospitals increased from 2004 to 2009, more than doubling as a proportion of total ambulatory surgical volume. The reasons for this trend are uncertain, but possible explanations include decreased quality of

newborn circumcision, increases in the total number of circumcisions being performed, or changing expectations regarding “normal” penile appearance after circumcision.

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Figure 1.

Increase in the rates of penile surgical procedures as a function of the total male ambulatory surgical volume from 2004–2009. Increases in RC were significantly greater than increases in LPA or PC ($p < .001$). Since the CPT code for LPA was released in 2002 along with the code for RC, the increases in LPA may be due to the effect of new code usage. Even after adjusting for increases in LPA, the increase in RC was still significantly greater than the increases in PC ($p < .001$).

Figure 2.
Increases in RC rates were found across all four major regions from 2004–2009.

Figure 3.

Percent increase in revision circumcision rates demonstrated significant variation ($p < .001$) among the 13 hospitals providing data for all years (2004–2009). The change in rate ranged from –36% to nearly 1100% with 6/13 hospitals demonstrating an increase of over 100%.

Table 1

Patient Demographics Compared to entire cohort

	Revision Circumcision N (%)	PHIS Cohort (Male Ambulatory Volume) N (%)
Total number of patients	5,632 (100%)	676,369 (100%)
Mean patient age, in years [Standard deviation]	2.5 [± 2.8]	5.4 [± 4.9]
Patient Age, By Category		
0–1 years	1,848 (33%)	187,446 (27.7%)
1–3 years	2,413 (43%)	126,211 (18.7%)
3–6 years	796 (14%)	140,444 (20.8%)
6–12 years	454 (8%)	137,716 (20.4%)
12–18 years	121 (2%)	84,552 (12.5%)
Race/Ethnicity [*]		
White	3,025 (60%)	402,649 (64%)
Black	1,284 (26%)	99,477 (16%)
Hispanic	215 (4%)	77,473 (12%)
Other	491 (10%)	52,114 (8%)
Insurance Type [‡]		
Private Insurance	1,860 (38%)	258,965 (41%)
Public Insurance	3,099 (62%)	365,774 (59%)
Treating Surgeon		
Pediatric Urologist	4,470 (79%)	N/A
Pediatric Surgeon	1,162 (21%)	N/A
U.S. Census Region		
Northeast	298 (5%)	53,032 (8%)
Midwest	1,900 (34%)	192,492 (28%)
South	2,946 (52%)	316,444 (47%)
West	488 (9%)	114,401 (17%)

* Race/Ethnicity data were missing for 617 (11%), and 44,656 (7%) ambulatory surgeries.

‡ Insurance type missing for 673 (12%) of RC, and 51,630 (8%) ambulatory surgeries.

Table 2

Summary of additional simultaneous procedures performed during the same operative episode as RC, PC, or LPA. These procedures are additionally stratified into genitourinary and other procedure types.

	Revision Circumcision N (%)	Primary Circumcision N (%)	Lysis of Penile Adhesions N (%)
Total number of patients	5,632 (100%)	25,768 (100%)	3,168 (100%)
Number of Additional Procedures			
None	4,275 (76%)	20,131 (78%)	2,209 (70%)
One	975 (17%)	3,904 (15%)	625 (19%)
Two	317 (6%)	1,338 (5%)	270 (9%)
Three	62 (1%)	385 (1%)	62 (2%)
Four (or more)	3 (<1%)	10 (<1%)	2 (<1%)
Additional Simultaneous Genitourinary (GU) Procedures			
Hernia/Hydrocele	332 (6%)	1,774 (7%)	364 (11%)
Orchidopexy	203 (4%)	917 (4%)	204 (6%)
Cystoscopic Procedures	27 (<1%)	228 (1%)	34 (1%)
Varicocele	1 (<1%)	9 (<1%)	2 (<1%)
Scrotal Procedure	89 (2%)	488 (2%)	60 (1%)
Other Genital	138 (2%)	389 (2%)	38 (1%)
Total with 1 Additional Simultaneous GU	665 (12%)	3,281 (13%)	568 (18%)
Other Additional Simultaneous Procedures			
Umbilical Hernia	34 (<1%)	283 (1%)	33 (1%)
Tympanostomy	66 (1%)	334 (1%)	34 (1%)
Other	598 (11%)	1,804 (7%)	337 (11%)
Total with 1 Additional Simultaneous Other	698 (12%)	2,421 (9%)	404 (13%)