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Trends in Medial Ulnar Collateral Ligament Reconstruction in the United States

A Retrospective Review of a Large Private-Payer Database From 2007 to 2011

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Background: Overuse injuries to the elbow in the throwing athlete are common. Ulnar collateral ligament reconstruction (UCLR), commonly known as Tommy John surgery, is performed on both recreational and high-level athletes. There is no current literature regarding the incidence and demographic distribution of this surgical procedure in relation to patient age, location within the United States, and sex.

Purpose: To determine the current demographic distribution of UCLR within the US population included in the PearlDiver database.

Study Design: Descriptive epidemiology study.

Methods: A retrospective analysis of the PearlDiver supercomputer database, a private-payer database, was performed to identify UCLR procedures performed between 2007 and 2011. The Current Procedural Terminology (CPT) code 24346 (reconstruction of the ulnar collateral ligament of the elbow with the use of a tendinous graft) was used.

Results: Between 2007 and 2011, a total of 790 patients underwent UCLR. The average (\pm SD) annual incidence was 3.96 ± 0.38 per 100,000 patients for the overall population but was 22 ± 3.4 for patients aged 15 to 19 years. The overall average annual growth was 4.2%. There were 695 males and 95 females. The 15- to 19-year-old patients accounted for significantly more procedures than any other age group (56.8%; $P < .001$), followed by 20- to 24-year-olds (22.2%). The incidence of UCLR in the 15- to 19-year-old group increased at an average rate of 9.12% per year ($P = .009$). Significantly more UCLR procedures were performed in the southern United States than in any other region ($P < .001$). The number of procedures significantly increased over time ($P = .039$).

Conclusion: According to this database of a privately insured population, UCLR was performed significantly more in patients aged 15 to 19 than any other age group. The average annual incidence of UCLR per 100,000 people for patients aged 15 to 19 was 22 ± 3.4 . Further, this database showed that the number of UCLR procedures is increasing over time. Further work should address risk reduction efforts in this at-risk population.

Keywords: ulnar collateral ligament (UCL) reconstruction; elbow; Tommy John; epidemiology; pitcher; incidence; United States

Over the past 15 years, ulnar collateral ligament reconstruction (UCLR) of the elbow has become a common procedure among both adolescent and elite-level athletes.^{3,18} First described by Jobe et al in 1986,¹⁰ UCLR has allowed athletes, most commonly pitchers, to return to sport, and to do so at a high level, after what was once thought to be a career-ending injury.^{4,5,10} Recent evidence has shown

a significant increase in the number of UCLR procedures performed on Major League Baseball (MLB) pitchers, with only 1 surgery performed in 1986 and 32 performed in 2012 in MLB.^{5,14}

Although most media and literature regarding UCLR surround MLB and elite-level pitchers, this cohort of players makes up a very small percentage of the overall patient population undergoing these procedures. National Collegiate Athletic Association (NCAA) research has shown that only 1 in 200 (0.5%) high school baseball players will play MLB.¹⁶ Thus, high school and college-aged pitchers must be analyzed to determine whether UCLR in these players is increasing at

the same rate as for MLB pitchers. Azar et al² reviewed the cohort of patients who underwent UCLR performed by Dr James Andrews and noted that in 1988-1994, only 8% (7 total) of the patients who underwent UCLR were high school athletes, and in 1995-2003, 13% (77 total) of the patients who underwent UCLR were high school athletes.

The purposes of this study were to determine (1) the incidence of UCLR reported in a private-payer database of patients in the United States, (2) the rate of increase of UCLR in these patients, (3) the age distribution of patients in this database undergoing UCLR in 2007-2011, (4) the regions of the United States in which UCLR procedures captured in this database are performed, and (5) the quarterly distribution of the performance of UCLR in this database. The authors hypothesize that in this US database population, there will be a significant increase in the number of UCLR procedures performed over time, the most common age group to undergo UCLR will be teenagers, the majority of UCLR procedures will be performed in the second quarter of the year, and the majority of UCLR procedures will be performed in the southern region of the United States.

METHODS

A retrospective review of the PearlDiver database was conducted to capture UCLR procedures performed in 2007-2011. Data from 2012 and 2013 were not available. The PearlDiver database is a publicly available national database that is compliant with the Health Insurance Portability and Accountability Act (HIPAA). The database uses supercomputer technology to collate individual patient records associated with Current Procedural Terminology (CPT) and International Classification of Diseases, Ninth Revision (ICD-9) codes related to orthopaedic procedures. This study selected patients with the CPT code 24346, which is defined as reconstruction of the ulnar collateral ligament of the elbow with the use of a tendinous graft, to query the database.

The primary data points that were extracted included patient age at the time of surgery (broken down into the following age groups: 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, and 55-59 years), year of surgery, quarter of the year during which surgery was performed, patient sex, location of surgery (outpatient hospital, inpatient hospital, surgical center), and geographic region of the United States (divided into Northeast, South, West, and Midwest) in which surgery was performed. The number of patients in the specific age groups previously listed, as well as the overall number of patients in the database for each year of 2007-2011, was recorded and used as the "population at risk" to determine the incidence.

Distributions over US region and quarter of the year were compared with an equal grouped frequency distribution, while age groups were compared with the proportion of the US population as reported in the 2011 US Census estimates. A chi-square goodness-of-fit test was used to calculate differences in UCLR procedure utilization, while Poisson regression was used to calculate annual trends in the number of UCLR procedures. Statistical significance was determined with a *P* value less than .05. Statistical analyses were performed using Stata (version 12.1; StataCorp).

RESULTS

In the period 2007-2011, 790 patients in this database underwent UCLR (Table 1). Of these patients, 695 were male (88%) and 95 were female (12%), a ratio of 7.3:1. The majority of the UCLR procedures were performed in patients aged 15-19 years (56.8%; *P* < .001), followed by 20- to 24-year-olds (22.2%) (Figure 1). More UCLR procedures (53%) were performed in the South than in the West, Midwest, and Northeast regions (*P* < .001). The annual calendar quarterly distribution for UCLR is shown in Figure 2, with most surgeries performed in the second quarter (April-June) (*P* < .001). Of all UCLR procedures performed during 2007-2011, 58% were performed in an outpatient hospital setting, 40% were performed at a surgical center, and 3% were performed in the inpatient hospital setting.

The number of UCLR procedures significantly increased over time (*P* = .039) (Table 1) and showed an average of 4.2% annual growth rate from 2007 to 2011. Furthermore, in the 15- to 19-year-old group, in which the most surgeries were performed, the overall number of UCLR procedures performed significantly increased over time, with an annual growth of 9.84% (*P* = .005). The overall average (\pm SD) annual incidence of UCLR per 100,000 people was 3.96 ± 0.38 , while the average annual incidence of UCLR per 100,000 people for patients aged 15-19 was 22 ± 3.4 . This incidence of UCLR in the 15- to 19-year-old group also significantly increased over time at an average rate of 9.12% per year (*P* = .009) (Figure 3). Hence, both the overall number and the incidence of UCLR in 15- to 19-year-olds significantly increased over time in the years 2007-2011.

DISCUSSION

UCLR has become a common procedure in both elite MLB pitchers and high school athletes.^{2,5} The incidence of UCLR in elite pitchers has been previously reported as steadily increasing over the past 10 years.^{5,14} The incidence

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TABLE 1
Number of UCLR Patients per Year and per Age Group, Overall Population at Risk, and Incidence per 100,000 People^a

Age Group, y	2007			2008			2009			2010			2011		
	No. of UCLR	Pop at Risk	Incidence	No. of UCLR	Pop at Risk	Incidence	No. of UCLR	Pop at Risk	Incidence	No. of UCLR	Pop at Risk	Incidence	No. of UCLR	Pop at Risk	Incidence
10-14	6	365,636	1.64	6	374,076	1.6	10	370,928	2.7	2	373,042	0.54	4	384,239	1.04
15-19	79	403,156	19.6	73	409,866	17.8	88	406,958	21.6	103	402,853	25.6	106	419,323	25.3
20-24	39	304,108	12.8	31	305,587	10.1	35	293,982	11.9	37	286,080	12.9	34	338,525	10
25-29	5	406,058	1.23	4	409,821	0.98	4	394,821	1.01	3	378,301	0.79	10	389,174	2.6
30-34	3	497,671	0.6	2	502,214	0.4	4	494,571	0.81	5	487,977	1.02	0	498,631	0
35-39	4	607,937	0.66	4	614,152	0.65	1	595,551	0.17	7	578,713	1.21	2	574,335	0.35
40-44	2	670,629	0.3	5	668,875	0.75	6	647,605	0.93	1	648,725	0.15	3	672,665	0.44
45-49	5	755,212	0.66	3	766,061	0.39	6	744,725	0.81	3	742,912	0.4	5	748,462	0.67

^aPop, population; UCLR, ulnar collateral ligament reconstruction.

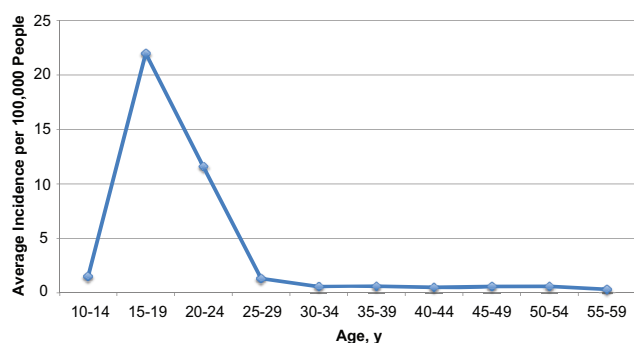


Figure 1. Overall average incidence of ulnar collateral ligament reconstruction by age of patients in the PearlDiver database in 2007-2011.

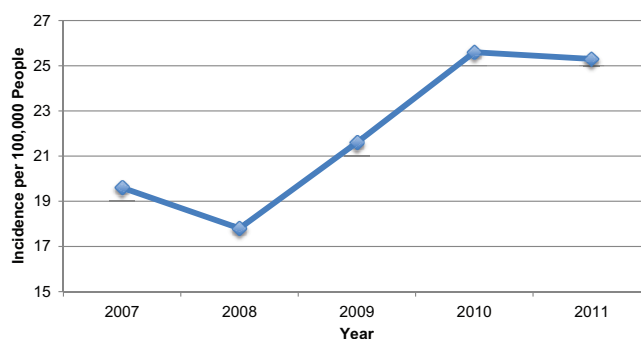


Figure 3. Annual incidence of ulnar collateral ligament reconstruction in patients aged 15-19 in the PearlDiver database in the years 2007-2011.

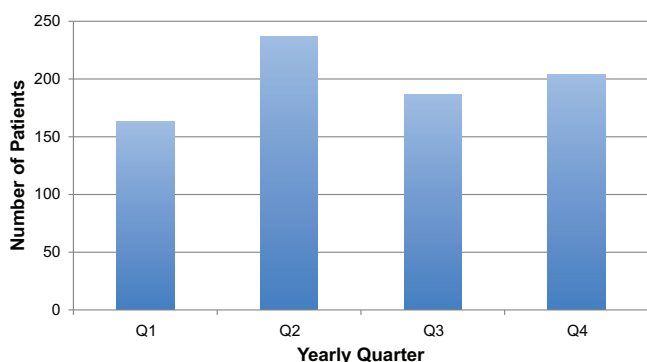


Figure 2. Yearly quarter distribution of ulnar collateral ligament reconstruction of patients in the PearlDiver database in 2007-2011.

of this procedure in the general population is not well understood. The purposes of this study were to determine the incidence of UCLR in the United States, the rate of growth of UCLR in the United States, and the age distribution of UCLR in the United States in the years 2007-2011. The authors' hypotheses were confirmed, in that there was a significant increase in the number of UCLR

procedures performed in the United States over the time studied, the most common age group of patients undergoing UCLR were late teenagers (specifically aged 15-19 years old), the majority of surgeries were performed in the second quarter of the year, and the majority of UCLR procedures were performed in the southern region of the United States.

It has been well established that the number of MLB pitchers who have undergone UCLR has been increasing since the 1980s to 2012 and has continued to increase in 2013 and 2014.^{5,14} While Azar et al² found an increase in the percentage (from 8% to 13%) and number (from 7 to 77) of high school athletes who underwent UCLR, the overall US population has not been studied. The data from this PearlDiver database have shown that the number of UCLR procedures performed each year is significantly increasing at an average of 4.2% per year in the overall population and 9.84% in patients aged 15-19. This statistic is important, as the majority of these players who are undergoing UCLR are in the 15- to 19-year age group (Figures 1 and 3). The current study found an overall average incidence per 100,000 patients of 3.96 ± 0.38 , with the number of patients in the overall database remaining relatively constant over the time period analyzed. However, the average annual incidence of UCLR per 100,000 people for patients aged 15-19 was 22 ± 3.4 (Figure 3). This is a staggering

statistic and may be due, in part, to the public perception surrounding UCLR. While this overall incidence of UCLR of 3.96 per 100,000 patients has not surpassed the overall incidence of anterior cruciate ligament reconstruction (ACLR) (recent population studies from the United States have shown an annual incidence of 43.5 per 100,000 person-years), further population studies are needed to determine how close UCLR has come to surpassing ACLR in the 15- to 19-year-old group.^{9,15,19}

Cain et al³ reviewed 1281 patients who underwent UCLR in 1988-2006 performed by Dr James Andrews. In the latter years of their study, 2003-2006, more than 700 UCLR procedures were performed, the majority in patients older than 18 years. Similarly, Osbahr et al¹⁷ reviewed 313 patients who underwent UCLR at 10-year follow up and reported an average age of 22.1. Again, these patients underwent UCLR in the early 2000s. However, our study found that in the specific patient population evaluated for this paper, the majority of UCLR procedures were performed in patients between 15 and 19 years of age. As the time period for the Cain and the Osbahr studies was early 2000s and the years of this study were 2007-2011, this may represent a shift in the age at which UCLR is performed as more and more patients attempt to have the surgery done earlier in their careers.^{3,17} This paradigm shift should be further evaluated.

In 2012, Ahmad and colleagues¹ issued a survey that was completed by 189 baseball players (both high school and college), 31 baseball parents, and 15 baseball coaches to assess public perception of UCLR. The goal of the questionnaire was to measure the surveyed participants' perception of UCLR as it related to indications, risks, recovery time, operative technique, and benefits. Interestingly, 51% of high school athletes, 26% of college athletes, 30% of coaches, and 37% of parents thought UCLR should be performed as a prophylactic procedure on healthy patients to enhance performance. Unfortunately, although UCLR can restore some pitchers to their preoperative level of function, it has not been shown to improve performance (pitch velocity, accuracy, etc).^{5,12,14} Furthermore, 28% of players, 31% of coaches, and 25% of parents did not think that the number of pitches thrown by a pitcher was a risk factor for sustaining an ulnar collateral ligament (UCL) injury, and 44% of parents, 24% of players, and 20% of coaches believed that the average return to sport time was less than 9 months.¹ The number of pitches a player throws in a given period of time has been shown to be a risk factor for UCL injury, and the average return to sport time has not been clearly defined but is generally considered to be over 1 year.^{5,7,13,14,20}

UCLR was most frequently performed during the second quarter of the year (April-June) (Figure 2). As baseball is typically played from February to October, pitchers are throwing competitively during these months of the year. While there are geographic areas where baseball is a year-round sport, the majority of players are in the off-season from October to February.⁸ Unlike some injured athletes, a pitcher who requires UCLR would have a hard time waiting until the end of the season (quarter 4) and so often undergoes surgery at the time of injury.^{3,4,11} Also, this is the time of year when

children are finishing school, and it may be that parents did not want their children to miss time at school for surgery. This is reflected in the data from this study, which show that more patients underwent UCLR between April and June than in any other quarter of the year, indicating that the majority of injuries occur during the season and, more importantly, at the beginning of the season. This finding is important for injury prevention, because it shows that the majority of resources should be dedicated to ensuring athletes transition well from off-season to in-season, as this is the time when most sporting injuries occur (transitioning from little activity to peak activity). In addition, the majority of UCLR procedures were performed in the Southern United States. This is likely multifactorial. First, studies have shown that pitchers who come from warm climates are more likely to undergo UCLR than those from cold climates, leading to a higher number of UCLR procedures performed in the South.⁶ Furthermore, Dr Andrews, who performs a high volume of UCLRs, practices in the South.^{3,17}

Limitations

The limitations of this study include the use of a private-payer database that does not include the entire population of the United States. This adds a degree of sampling bias to the results as some athletes may not have been included in this sample if they did not have access to private-payer insurance. Furthermore, the patients included in the database may have been privileged, with pressure to perform consistently at high levels—hence the high number of UCLR procedures. Patients' parents may also have been able to afford the cost associated with this procedure, including medical and rehabilitation expenses, ensuring that money was not an issue for surgery. This study used the CPT code 24346 only. This may have missed some patients who were erroneously coded with various other CPT codes such as 24345 (repair of the UCL), although it is our belief that UCLR should routinely be coded as 24346. Furthermore, if the 24345 code was used, the search may have found duplicate patients if the surgeons coded for both 24346 and 24345 in the same patient, thereby falsely elevating the results. It is also possible that when the coders entered the CPT codes into the database, the numbers were entered incorrectly, thereby increasing or decreasing the actual numbers. The activity levels of the patients undergoing UCLR, as well as their sport played, level of sport, nonoperative treatment regimen, and revision status, were not known to this review. However, the strengths include the number of patients analyzed through this database, the data points that were available, and the ability to determine the incidence and increase of UCLR over time.

CONCLUSION

According to the privately insured database used in this study, UCLR was performed significantly more in patients aged 15-19 years than any other age group. The average annual incidence of UCLR per 100,000 people for patients

aged 15-19 was 22 ± 3.4 . Further, in this database, the number of UCLR procedures is increasing over time. Further work should address risk reduction efforts in this at-risk population.

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