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Trends of Ulnar Collateral Ligament Reconstruction in the United States from 2003 to 2014: Analysis of 3,133 Patients



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Purpose: The purpose of this study is to investigate the trends concerning ulnar collateral ligament (UCL) reconstruction (UCLR) for athletic injuries within the United States over the years 2003 to 2014. **Methods:** A retrospective review of the Truven Health Marketscan® Commercial Database was conducted for patients undergoing UCLR. Data was reviewed for patients treated between 2003 and 2014, and the cohort of patients undergoing UCLR was queried using Common Procedural Terminology code 24346. Patients ages 11 to 40 years were included and divided into 6 different age groups, with the rate of UCLR calculated for each group. **Results:** The overall rate of UCLR increased from 4.4 per million in 2003 to 11.9 per million in 2014 ($p < .01$). Throughout the same time period, the rate per million increased from 3.3 to 22.1 in 11- to 15-year-olds ($p < .01$), from 105.4 to 293.2 in 16- to 20-year-olds ($p < .01$), from 23.1 to 67.0 in 21- to 25-year-olds ($p < .01$), and from 2.1 to 5.7 in 31- to 35-year-olds ($p < .01$). There was no significant increase in the rate of UCLR in the age groups of 26 to 30 and 36 to 40 years. **Conclusion:** UCLR was mostly performed in patients aged 11 to 25 years (96.6%), and specifically most common in those patients aged 16 to 20 years (67.4%). The rate of UCLR procedures increased over time for younger age groups significantly more than for their older counterparts. **Clinical Relevance:** UCLR rates are increasing in young patients despite efforts addressing injury risk reduction strategies and education for coaches, players, and parents regarding risk factors for UCL injury.

The ulnar collateral ligament (UCL) is a primary elbow stabilizer and critical for valgus stability of the joint.¹ The ligament originates at the posterior distal aspect of the medial epicondyle and inserts into the base

of the medial coronoid process. It is composed of 3 bands: anterior, posterior, and transverse. UCL injuries are most commonly due to repetitive overhead throwing motions that transmit valgus stress to the anterior band of the UCL.² Less frequently, these injuries are due to traumatic stress to the elbow during a fall on an outstretched hand that may cause dislocation of the elbow, as well as rupture of the UCL.

Jobe et al.³ first described successful surgical treatment for these injuries in 1986. Since that time, not only has the technique been modified, but the surgery, colloquially called Tommy John surgery, has also gained widespread media attention for its connection to professional baseball and its perceived ability to improve the pitching velocity of these top-tier athletes.⁴ Although the procedure has been proven to aid in return to sport for these athletes, evidence has demonstrated that the pitching velocity of these athletes actually remains the same or decreases slightly.⁵ Despite this, there has been a steady increase in the number of ulnar collateral ligament reconstructions (UCLRs) done for MLB pitchers, denoting the procedure's popularity and perceived effectiveness.⁶

Public perception of this surgery has grown even more within the United States, as athletes are engaging

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Table 1. Inclusion: Common Procedural Terminology (CPT) Codes

CPT Code	Description
24346	Repair medial collateral ligament, elbow, with tendon graft, including graft harvest
64718	Neuroplasty and/or transposition; ulnar nerve at elbow
29830, 29834, 29835, 29836, 29837, 29838	Arthroscopy of elbow

in competitive sports at increasingly younger ages and devoting more time year-round to these endeavors. Furthermore, it is well documented that overuse in the form of increased playing time per year and increased pitches per game is the main cause of UCL injury.⁷ In fact, in a single surgeon's series, an alarming 11-fold increase was noted in UCLRs performed on high school pitchers between 1998 and 2003.⁸

The aim of this study is to investigate the trends concerning UCLR for athletic injuries within the United States over the years 2003 to 2014. We hypothesize that the overall rate of UCLRs will increase over the specified time period, and the younger age groups will demonstrate a higher increase in the rate relative to their older counterparts.

Methods

A retrospective review of the Truven Health MarketScan® Commercial Database was conducted for patients undergoing UCLRs. This database houses deidentified records for ~55 million patients in the United States <65 years old with private or employer-provided coverage, spanning 2003 to 2014. The database contains 7 tables, including inpatient admission, facility header, inpatient service, outpatient service, population, outpatient pharmaceutical claims, and enrollment. The inpatient services and outpatient services tables were used in this study. Records include, among other information, general demographics, payer data, *International Classification of Diseases, Ninth Revision* diagnosis codes, billed costs for medications and office visits, and claims for Current Procedural Terminology (CPT) codes with associated dates. This study received no external funding and, given the deidentified nature of the dataset, was exempted from review by the institutional review board.

Data were reviewed for patients treated between 2003 and 2014, and the cohort of patients undergoing UCLR was queried using the CPT code 24346 (Table 1). Patients ages 11 to 40 years were included, to minimize the possibility of UCLRs performed for congenital deformities and nonathletic injuries.

The frequency of the CPT code 24346 was identified per year, and then the rate of the procedure per million was calculated relative to the number of patients

enrolled in the database per year. The trend of the mean age of the patients was analyzed and plotted over the decade spanning the study time interval, along with the percentage of surgeries having concomitant ulnar nerve decompression and utilization of arthroscopy. Patients were divided into 6 different age groups: 11 to 15, 16 to 20, 21 to 25, 26 to 30, 31 to 35, and 36 to 40 years. The population of each age group in the database per year was collected, and the rate of UCLR was calculated in each group annually, along with the percentage of the surgery each group represents during each year. Patients who underwent any type of fracture or dislocation procedures on the humerus, proximal radius, or the elbow along with the UCLRs were excluded (Table 2).

Logistic regression models were used to analyze the significance of the trends over the years. All analyses used SAS 9.3 and SPSS. Significance was set at $p < .05$ for all statistical testing.

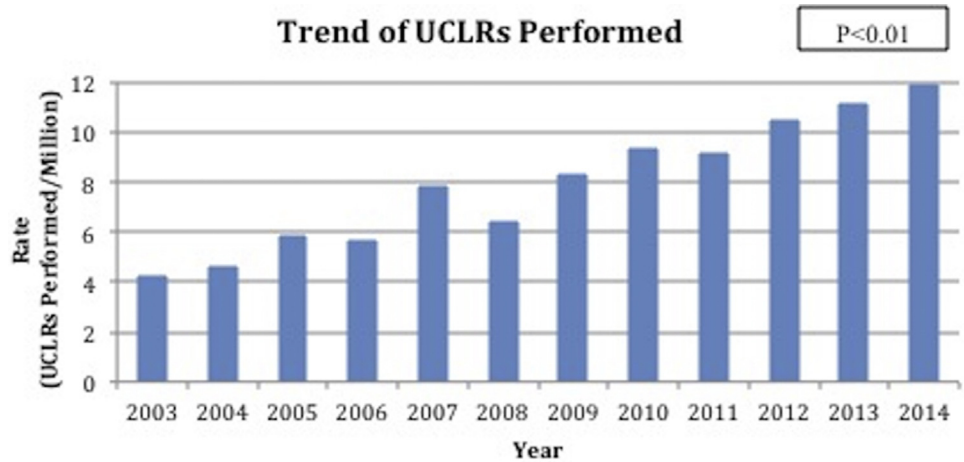
Results

Included in the study were 3,133 patients, 2,791 males (89.1%) and 342 females (10.9%). The mean age of the sample was 19.1 ± 4.1 years. The overall rate of UCLR increased from 4.4 per million in 2003 to 11.9 per million in 2014 ($p < .001$) (Fig 1). Throughout the same time period, the rate per million increased from 3.3 to 22.1 in the age group of 11 to 15 years ($p < .01$), from 105.4 to 293.2 in the age group of 16 to 20 years ($p < .01$), from 23.1 to 67.0 in the age group of 21 to 25 years ($p < .01$), and from 2.1 to 5.7 in the age group of 31 to 35 years ($p < .01$). There were no significant increases in the rates of UCLR in the age groups of 26 to 30 or 36 to 40 years (Fig 2).

Table 2. Exclusion: Common Procedural Terminology (CPT) codes

CPT Code	Description
24685	Open treatment of ulnar fracture proximal end (olecranon process), with or without internal or external fixation
24666	Open treatment of radial head or neck fracture, with or without internal fixation or radial head excision; with radial head prosthetic replacement
24575	Open treatment of humeral epicondylar fracture, medial or lateral, with or without internal or external fixation
24366	Arthroplasty, radial head, with implant
24586	Open treatment of periarticular fracture and/or dislocation of the elbow (fracture distal humerus and proximal ulna and/or proximal radius)
24120	Excision or curettage of bone cyst or benign tumor; radial head or neck or olecranon process
24579	Open treatment of humeral condylar fracture, medial or lateral, with or without internal or external fixation
24140	Partial excision, humerus
20680	Removal of implant; deep, eg, buried wire, pin, screw, metal band, nail, rod or plate) removal of hardware
24665	Open treatment of radial head or neck fracture, with or without internal fixation or radial head excision

Fig 1. Trend of overall ulnar collateral ligament (UCL) reconstructions performed from 2003 to 2014.



There were 298 (9.5%) patients in the age group 11 to 15 years; 2,222 (70.9%) in the age group 16 to 20 years; 509 (16.2%) in the age group 21 to 25 years; and the remaining 104 (3.3%) in the older age groups (26 to 40 years). From 2003 to 2014, the percentage of UCLRs represented by the age group 11 to 15 years increased from 4.6% to 10.2%, and from 11.0% to 17.1% in the age group 21 to 25 years, but decreased from 76.6% to 67.4% in the age group 16 to 20 years, from 3.1% to 1.5% in the age group 26 to 30 years, from 3.1% to 1.7% in the age group 31 to 35 years, and from 1.6% to 1.5% in the age group 36 to 40 years (Fig 3).

Overall, 1,340 (42.8%) patients underwent ulnar nerve transposition, and 330 (10.5%) patients underwent arthroscopic surgery during UCLR. The mean age of the sample did not significantly decrease from 2003 to 2014 ($p = .18$). There was an increase in percentage of

utilization of ulnar nerve transposition from 31.3% in 2003 to 47.8% in 2014, but it was not significant ($p = .20$) (Fig 4). Finally, percentage utilization of arthroscopy throughout the time period oscillated, and there was no significant trend ($p = .34$) (Fig 5).

Discussion

Our study demonstrated an increase in the rate of the surgery by a factor of almost 2.7, from 4.4 per million in 2003 to 11.9 per million in 2014, a result that is compatible with those of the previous investigations.⁹⁻¹¹ After stratifying the study population by age, 3,029 patients (96.7%) were <25 years old. Moreover, the rate of UCLR only increased in the age groups of 11 to 15, 16 to 20, 21 to 25, and 31 to 35 years. Although statistically significant, the rate of increase in the 31- to 35-year olds was not clinically important. These results might reflect the current sports

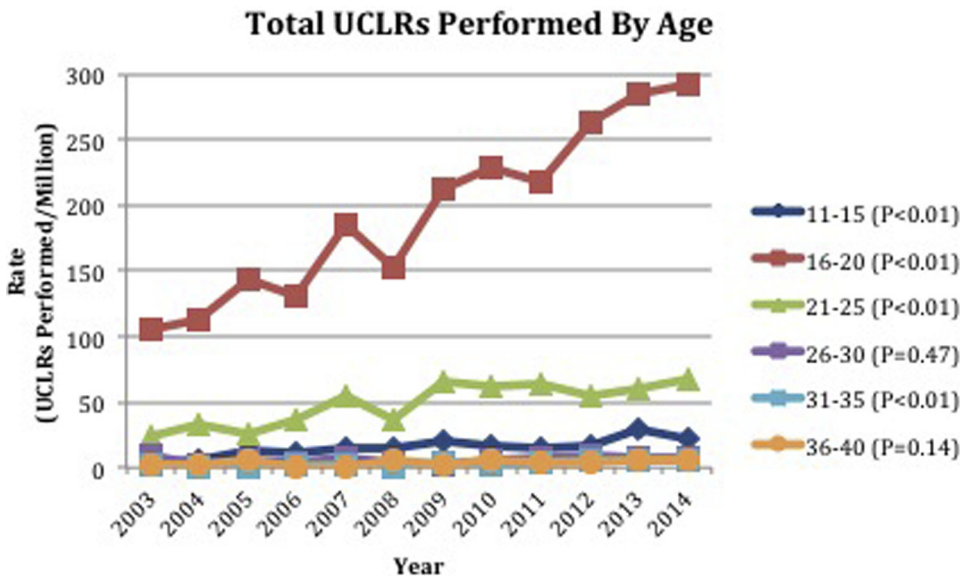


Fig 2. Rate per million relative to age from 2003 to 2014.

Breakdown of Total UCLRs Performed by Age

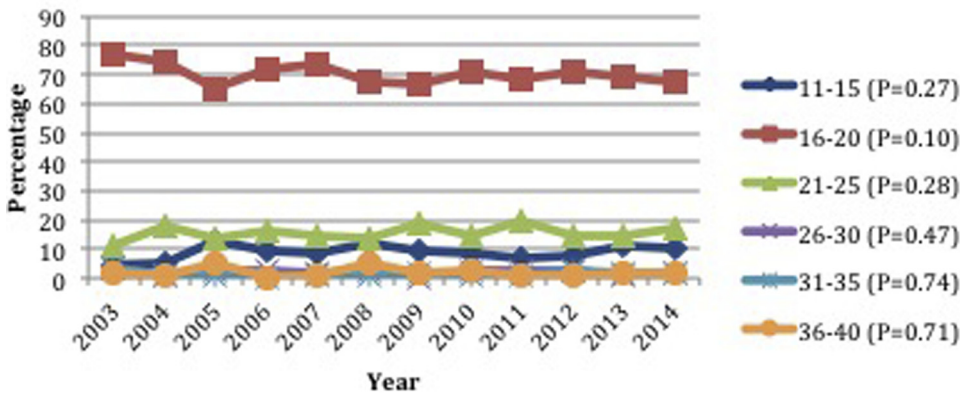


Fig 3. Percentage of ulnar collateral ligament (UCL) reconstructions relative to age from 2003 to 2014.

culture within the United States, in which younger athletes are participating in competitive baseball tournaments year-round, thus throwing more frequently and increasing the risk for UCL injury.¹² To combat this, the Little League Baseball and Softball organization introduced pitch count restrictions in 2006 to limit the number of practice and competitive pitches that an athlete may throw on the basis of age and to encourage appropriate rest from throwing relative to the number of pitches thrown.¹³ These guidelines were revisited and expanded into the Pitch Smart program in 2014.¹⁴ Despite guidelines like these having been around since 2006, the data in this article, as well as previous research, suggest that these guidelines are not followed strictly or are inadequate.

The success rate of UCLR, along with the successful return of Major League Baseball players to regular play, may also be contributing to the nonadherence of young athletes to current protective throwing guidelines. Perpetuating the nonadherence to these guidelines and the rise of UCLR rate within the young population is the misconception and uninformed nature of the coaches, players, and players' parents about the risk factors for UCL injuries. In a survey given to high-school baseball teams, 31% of coaches, 28% of players, and 25% of players' parents did not believe the number of pitches thrown to be a risk factor for UCL reconstruction, and 30% of coaches, 51% of players, and 37% of parents believed surgery should be performed in the absence of elbow injury to enhance performance.⁴ Misconceptions regarding UCLR also exist in the media. In a survey of 516 members of the sports media, only 48.4% believed that pitch counts could help prevent UCL injuries, and 25% believed that UCLR was primarily done for enhancing athletic performance.¹⁵

Another possible reason for the increase in UCLR procedures could relate to increased availability of those providing surgery. Hodgins et al.¹⁰ reported that there

was a significant increase in the number of medical centers performing UCLR in the state of New York, rising from 10 medical centers in 2002 to 20 in 2011. This might be attributed to a greater number of advanced, fellowship-trained surgeons in UCLR, enhanced experience of surgeons with UCLR, and the availability of improved instrumentation, which collectively make surgeons more comfortable with the procedure and results in a greater proportion of surgeons who offer operative treatment compared with earlier times. Although it is reasonable to assume that this surge in the rate of operative treatment of UCL injuries is attributed to the increase of young patients participating in competitive baseball, it might also be worth investigating whether the proper indications of operative treatment are being used to perform UCLRs and whether certain patients should be treated nonoperatively.

The initial UCLR technique, first described by Jobe et al.,³ had high rates of ulnar nerve complications owing to the transposition of the ulnar nerve during surgery. However, the recently modified docking techniques and muscle-splitting approach do not include ulnar nerve transposition.¹⁶⁻¹⁸ This practice has reduced postoperative ulnar neuropathy from 9% to 4% and has increased the rate of excellent outcomes from 75% to 89%.¹⁹ Watson et al.²⁰ reported that

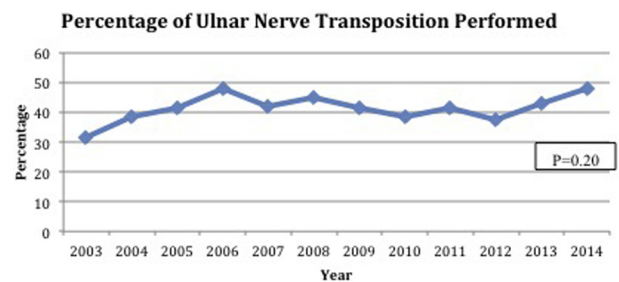


Fig 4. Percentage of concomitant ulnar nerve transposition from 2003 to 2014.

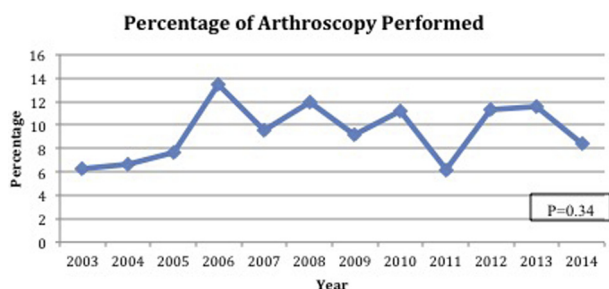


Fig 5. Percentage of concomitant arthroscopy from 2003 to 2014.

using docking techniques yielded complication rates ranging from 0% to 5%, and they recommend reserving ulnar nerve transposition for patients with preoperative neuritis. Given the current literature on these outcomes, it was expected that the rates of ulnar nerve transposition would decrease over the years, especially with a larger pool of newly trained physicians who would be more willing to align their practice with the most recent techniques of UCLR. However, there was no significant change in the rate of ulnar nerve transposition in this study. The reasons for this might be multifactorial. Although UCLR is now performed in an increasing number of institutions and by increasing number of physicians, the majority of them are still performed in few institutions and by relatively small number of physicians who have been performing UCLR for a long time, and thus may not be as willing to change their practice based on current literature. Lastly, as Hodgins et al.¹⁰ state, the addition of a procedural code to the operation provides a financial incentive for a concomitant ulnar nerve procedure, especially in an era of declining reimbursement.

The epidemiology of UCL injuries and UCLRs has been thoroughly studied within professional baseball, but, since the surgery was first described, very few studies have investigated their epidemiology and trends within the general population.⁶ Of the 3 studies that investigated the epidemiology and trends of this procedure, 2 of them focused on a single state, and the other focused on a relatively short period of time and did not account for cases caused by trauma.⁹⁻¹¹ This study investigated the trend of UCLRs over a period of 12 years and excluded those patients who underwent UCLR as a secondary surgery during fracture or dislocation treatment or for a congenital deformity. Also, our study's database represents claims throughout the United States, and no geographic biases would alter the magnitude and directionality of our findings in a clinically meaningful way. Thus, we do not believe geography is of concern in the interpretation of our results. MarketScan also has a quantity of patients unmatched by most other databases in medicine, allowing for a

unique analysis of the surgical procedures in question, and enabling us to discern even minor changes over time.

Limitations

Inherent to any database study are several limitations. First, any CPT code–based study relies on competent coding. The authors took several steps to minimize the effects of miscoding, but in a study of this size, some errant coding is certainly present. Second, the MarketScan® Commercial Database is limited to privately insured patients, and patients with Medicare without supplemental insurance and the uninsured are not included in the database population. Additionally, patients with lower socioeconomic status participate in fewer sporting activities and have less access to health care, and thus would have less theoretical risk of UCL injury, as well as fewer options for treatment.^{21,22} As such, this limits the generalizability of our study.

Conclusions

UCLR was mostly performed in patients 11 to 25 years old (96.6%), and specifically most common in those aged 16 to 20 years (67.4%). The rate of UCLR procedures increased over time for younger age groups, significantly more so than for their older counterparts.

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