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Epidemiology of Medial Ulnar Collateral Ligament Reconstruction

A 10-Year Study of New York State

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Background: Despite an increase in the prevalence of medial ulnar collateral ligament (UCL) reconstruction of the elbow in professional baseball and popularity within the media, there are no population-based studies examining the incidence of UCL reconstruction.

Purpose: To examine the epidemiological trends of UCL reconstruction on a statewide level over a 10-year period. The primary endpoint was the yearly rate of UCL reconstruction over time; secondary endpoints included patient demographics, institution volumes, and concomitant procedures on the ulnar nerve.

Study Design: Descriptive epidemiology study.

Methods: The New York Statewide Planning and Research Cooperative System (SPARCS) database contains records for each ambulatory discharge in New York State. This database was used to identify all UCL reconstructions in New York State from 2002 to 2011 using the outpatient CPT-4 (*Current Procedural Terminology, 4th Revision*) code. Assessed were patient age, sex, ethnicity, insurance status, and associated procedures, as well as hospital volume.

Results: There was a significant yearly increase in the number of UCL reconstructions ($P < .001$) performed in New York State from 2002 to 2011. The volume of UCL reconstructions increased by 193%, and the rate per 100,000 population tripled from 0.15 to 0.45. The mean $\pm$ SD age was 21.6 ± 8.89 years, and there was a significant trend for an increased frequency in UCL reconstruction in patients aged 17 to 18 and 19 to 20 years ($P < .001$). Male patients were 11.8 times more likely to have a UCL reconstruction than female patients ($P < .001$), and individuals with private insurance were 25 times more likely to have a UCL reconstruction than those with Medicaid ($P = .0014$). There was a 400% increase in concomitant ulnar nerve release/transposition performed over time in the study period, representing a significant increase in the frequency of ulnar nerve procedures at the time of UCL reconstruction ($P < .001$).

Conclusion: The frequency of UCL reconstruction is steadily rising in New York State and becoming more common in adolescent athletes. Emphasis on public education on the risks of overuse throwing injuries and the importance of adhering to preventative guidelines is essential in youth baseball today.

Keywords: incidence; ulnar collateral ligament (UCL) reconstruction; Tommy John surgery; overhead athlete

Injury to the medial ulnar collateral ligament (UCL) of the elbow is a debilitating condition primarily affecting the

throwing athlete. Its definitive surgical treatment involves ligament reconstruction followed by an extensive postoperative rehabilitation period. Often referred to as "Tommy John surgery," named for the first pitcher successfully treated by Dr Frank W. Jobe in 1974,¹³ it has been more recognized in sports medicine and baseball communities,¹ and popularity in the media has made it a preeminent sports injury.

Recently, the frequency of UCL reconstruction in Major League Baseball (MLB) has drawn increasing attention. As many as 10% of all active pitchers have undergone UCL reconstruction, and there has been an estimated 10-fold increase in reconstruction in the first decade of the 21st century.^{4,7,14} More alarming, evidence suggests this trend has translated to adolescent athletes, with a 50% increase

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in UCL reconstruction in high school baseball players ages 15 to 19 years reported by a single surgeon.²⁷ Pressures within the fierce competitive culture in youth baseball may encourage talented players to throw more frequently, with greater intensity and at a younger age. Clear associations have been demonstrated between the number of innings pitched in a calendar year and the chance of sustaining a serious injury.¹⁰ Overuse has been described as the main cause of player injury, with a 500% increase in risk for surgery for those pitching more than 8 months per year and a 400% increase risk for those throwing >80 pitches per game.^{16,25} In addition, public perception of the success of the UCL reconstruction may hinder compliance with injury prevention guidelines, creating a false sense of security for players' susceptibility to career-ending injury. When surveying 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.¹ Consequently, increasing pitch volumes combined with public misconceptions for the indications and outcomes of surgery may be creating a UCL reconstruction epidemic.

Despite being a well-recognized surgical procedure, little data exist regarding the incidence of UCL reconstruction. Large case series have demonstrated increases in frequency over time, and a single institution reported a 22-fold increase in ligament reconstruction between 1994 and 2010.^{4,8,15} Yet, it is unclear how this trend translates to the athletic population as a whole, with the true frequency of reconstruction likely multifactorial. The purpose of this investigation was to examine the epidemiological trends of UCL reconstruction on a statewide level over a 10-year period.

METHODS

This research protocol was reviewed by the Institutional Review Board of Columbia University Medical Center and was judged to be exempt from requiring consent. The New York Statewide Planning and Research Cooperative System (SPARCS) database²³ from the New York State Department of Health was surveyed for all UCL reconstructions performed from 2002 to 2011. The SPARCS ambulatory database contains records for each ambulatory discharge from nonfederal, state-licensed hospitals in New York verified for accuracy by the Department of Health. The records include information regarding patient demographics, primary and secondary diagnoses, and primary and secondary procedures. The SPARCS database has been used in numerous studies investigating procedure volume, incidence rates, epidemiological trends, and surgical outcomes for various orthopaedic procedures, including rotator cuff repair, acromioplasty, anterior cruciate ligament (ACL) reconstruction, total elbow and shoulder arthroplasty, and arthrodesis for scoliosis.^{6,11,19,20,24,32,35,36}

The UCL reconstruction procedures were identified using the CPT-4 (*Current Procedural Terminology, 4th*

Revision) code 24346 for outpatients that were reported in the SPARCS ambulatory database. However, the CPT-4 code for UCL reconstruction was introduced only after 2001, and therefore the study period was restricted to SPARCS records for 2002 to 2011 (the most recent year for which the SPARCS data were available at the time of the present study). An ICD-9-CM (*International Classification of Disease, 9th Revision, Clinical Modification*) code specific for UCL reconstruction performed on an inpatient basis does not exist within the SPARCS database, and this cohort was excluded. Concomitant ulnar nerve releases/transpositions were identified with the additional CPT-4 code 64718.

Demographic data were collected for each UCL procedure, including the age of the patient on the day of the procedure, sex, race/ethnicity, insurance payer, ICD-9 primary diagnosis codes (with evaluation of the primary but not secondary diagnosis code associated with any UCL procedure), location of the surgery (hospital-based or free-standing licensed ambulatory surgery center), and procedure year. Race/ethnicity was defined as *white*, *black*, *Hispanic*, *other*, and *unknown*. Primary reimbursement was defined as *private*, *HMO (health maintenance organization)*, *workers' compensation*, *all government*, and *other*. Facility identification numbers are available in the SPARCS database for each ambulatory discharge and were used to determine the number of institutions and institution volume of UCL reconstructions per year. Annual population estimates from 2002 to 2011 were obtained from the US Census Bureau intercensal estimates to calculate UCL reconstruction rates per 100,000 population of New York State.²²

Analysis was conducted using SAS 9.4 (SAS Institute). Descriptive statistics were obtained using exploratory data analysis (EDA) on all effects from the SPARCS ambulatory visit data. Frequency distributions for a variety of effects with chi-square measurements were presented. Continuous effects were not modified while categorical effects were converted to indicator values. Multiple tabulations were performed, including identification by study year, the principal diagnoses, and procedures by CPT-4 codes. Logistic regression was used to measure selected effects that predict the outcome variable of the UCL reconstruction population using truth logic.

RESULTS

A total of 444 medial ulnar collateral ligament reconstructions were performed between 2002 and 2011 in New York State (Table 1). There was a significant yearly increase in the number of UCL reconstructions ($P < .001$), with 30 index UCL reconstructions performed in 2002 and 88 performed in 2011 (Figure 1). Over 9 years, the volume of UCL reconstruction increased by 193% while the rate of UCL reconstruction per 100,000 population of New York State rose from 0.15 in 2002 to 0.45 in 2011 (Figure 2). An individual was 2.34 times (95% CI, 1.35-4.04) more likely to have a UCL reconstruction in 2011 compared with an individual in 2002 ($P = .0024$).

TABLE 1
Study Demographics^a

Reconstructions, n	444
Age, y, mean $\pm$ SD	21.6 $\pm$ 8.89
Hospitals, n	69
Sex	
Male	402 (90.5)
Female	36 (8.1)
Unknown	6 (1.4)
Race/ethnicity	
White	275 (61.9)
Black	10 (2.25)
Hispanic	8 (1.8)
Other	62 (13.9)
Unknown	89 (20.15)
Primary reimbursement	
Private	278 (62.6)
HMO	90 (20.2)
Workers' compensation	18 (4)
All government	18 (4)
Other	40 (11)
Location	
Ambulatory surgery center	210 (47.3)
Hospital	234 (52.7)
Ulnar nerve transpositions, n	59

^aValues are expressed as n (%) unless otherwise indicated. HMO, health maintenance organization.

The reconstructions were performed in a total of 69 distinct medical centers, and there was a significant increase ($P < .001$) in the number of centers performing UCL reconstructions from 2002 to 2011 (Figure 3). A single institution was responsible for 145 UCL reconstructions (33.1%), and 51 different institutions performed 5 or fewer UCL reconstructions ($P < .001$) over the 10-year study period. The setting in which UCL reconstruction was performed was relatively evenly distributed between hospitals (52.7%) and ambulatory surgery centers (47.3%), with a slight preference toward hospitals.

The mean $\pm$ SD age of the study population was 21.6 $\pm$ 8.89 years. When analyzed according to age cohort, there was a significant increase in frequency of UCL reconstruction in 17- to 18-year-olds and 19- to 20-year-olds ($P < .001$) over time, while rates in all other age cohorts remained relatively static (Figure 4). Men were 11.8 times (95% CI, 8.38-16.61) more likely to have a UCL reconstruction than women ($P < .001$) and consisted of 90.5% of the study population. Race/ethnicity profiles were primarily white (61.9%), while blacks were only 10.6% (95% CI, 5%-20%) as likely to have a UCL reconstruction compared with whites ($P < .001$), and non-Hispanics were 11.4 times (95% CI, 5.58-23.39) more likely to have the procedure than Hispanics ($P < .001$). Individuals with private insurance were 25 times (95% CI, 3.5-183.4) more likely to have a UCL reconstruction than those with Medicaid ($P = .0014$). A total of 59 concomitant ulnar nerve transpositions/ulnar nerve releases were performed during the study period. There was a significant yearly increase in the number of ulnar nerve procedures ($P < .001$), with 4 combined UCL reconstructions and ulnar

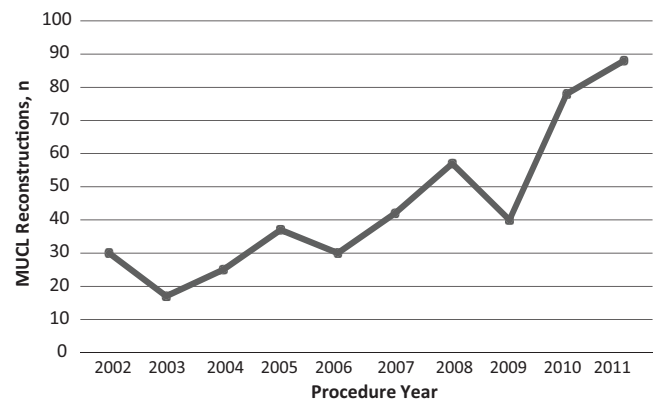


Figure 1. The number of medial ulnar collateral ligament (MUCL) reconstructions performed in New York State by year. There is a significant trend for a greater number of reconstructions performed over time ($P < .001$).

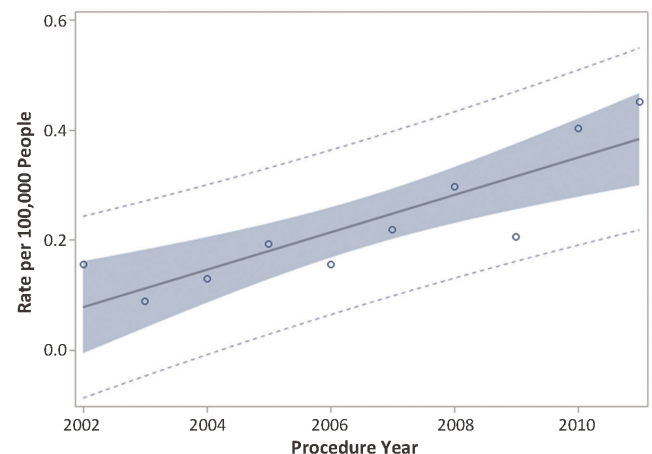


Figure 2. The rate of medial ulnar collateral ligament reconstructions per 100,000 people in New York State by year.

nerve transpositions performed in 2002 compared with 20 performed in 2011 (Figure 5).

DISCUSSION

Despite the “epidemic” of medial elbow injuries described in the media and the increasing rate of UCL reconstruction in professional baseball players, there are no population-based investigations examining this trend. Our study analyzed the epidemiology of UCL reconstruction on a state-wide level through mandatory reporting in a Department of Health database. We confirmed our hypothesis that the number of UCL reconstructions performed per year in New York State significantly increased from 2002 to 2011, at an overall rate of 193% over the study period. The number of UCL reconstructions per 100,000 population of New York State tripled in 10 years from 0.15 to 0.45. The frequency of concomitant ulnar nerve procedures also significantly increased by 400%.

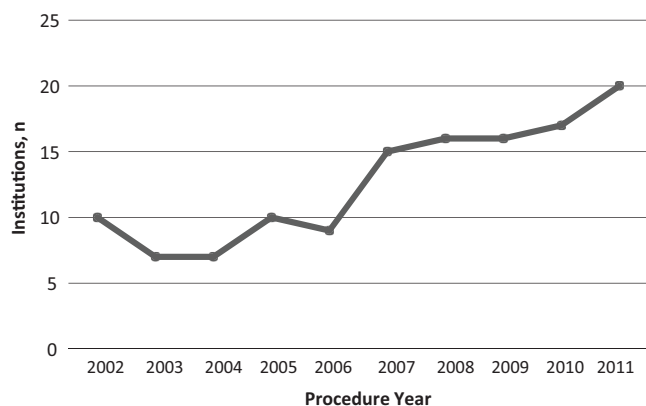


Figure 3. The number of institutions performing medial ulnar collateral ligament (UCL) reconstructions in New York State by year. There is a significant trend for a greater number of institutions performing UCL reconstruction over time ($P < .001$).

Professional baseball generates billions of dollars in annual revenue and is one of the most profitable and popular spectator sports in the United States.^{12,29} As such, injuries to the UCL in MLB pitchers receive tremendous attention, having substantial monetary implications for teams and championship consequences for fans. There has been a well-documented rise in the number of primary and revision UCL reconstructions in MLB pitchers, with an estimated prevalence of 10% among active players.^{4,14} The first decade of the 21st century has seen a 10-fold increase in UCL reconstructions in MLB, and that trend continues, including a record 36 procedures in 2012.⁵ Mainstream national media have described this phenomenon, publicizing the “epidemic” of Tommy John surgery.^{9,26} Injury statistics in MLB are readily accessible through the public domain and the MLB injury database, but outside of professional baseball, the epidemiology of UCL reconstruction is only speculated. Data are limited to large case series, which have demonstrated substantial increases in the frequency of the procedure, although caution should be taken when attempting to extrapolate these findings to larger populations.^{4,8,15} Medial ulnar collateral ligament reconstruction is a specialized operation performed by a select community of surgeons, and it is not uncommon for athletes to travel great distances to have the procedure. The surgeons as well as the operation itself have become well recognized, and this popularity has helped to increase individual surgeons’ case volumes of UCL reconstructions. The utilization of a statewide database to estimate frequencies of the procedure attempts to limit such biases. The SPARCS database has successfully examined the incidence of numerous procedures, including rotator cuff repair, acromioplasty, ACL reconstruction, total elbow and shoulder arthroplasty, and scoliosis correction.^{6,11,19,20,32,35,36} Our method is consistent with these prior studies. In our investigation, the population of New York State increased an estimated 2.0% from 2002 to 2011 in comparison to an absolute increase in UCL reconstruction of 193%.

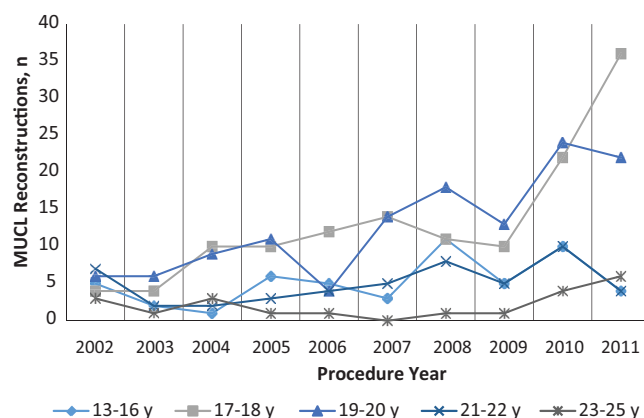


Figure 4. The number of medial ulnar collateral ligament (MUCL) reconstructions performed in New York State by age cohort. There is a significant trend for greater number of reconstructions performed in the 17- to 18-year and 19- to 20-year age groups ($P < .001$).

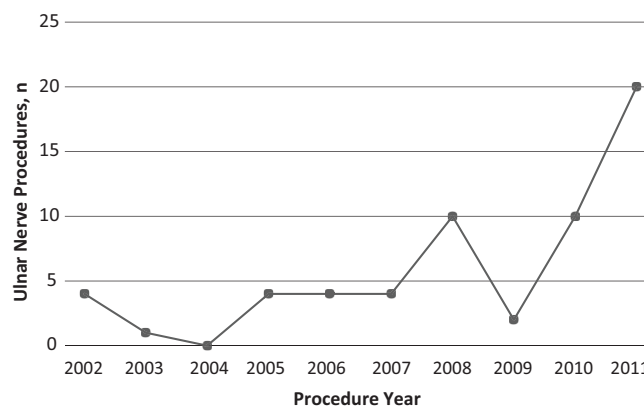


Figure 5. The number of concomitant ulnar nerve procedures performed in New York State by year. There is a significant trend for a greater number of procedures performed over time ($P < .001$).

Our study also analyzed UCL reconstruction by age cohort and found an increased frequency in the younger populations of patients aged 17 to 18 and 19 to 20 years over time. The rate of UCL reconstruction remained relatively unchanged in all other age cohorts over the study period. Interestingly, the 13- to 16-year-old cohort in our study did not demonstrate an increase in UCL reconstruction, and it is possible that this age group undergoes a more lengthy nonoperative treatment regimen and eventually has the procedure at an older age. These statewide findings are consistent with other institutional studies that have suggested an increase in the incidence of UCL injuries in adolescent athletes.^{15,25,27} A study by Petty et al²⁷ demonstrated a 50% increase in UCL reconstruction in high school athletes ages 15 to 19 years and suggested overuse as the number one risk factor for injury. Similarly, Jones et al¹⁵ described an increase in the incidence of UCL

injury in a series of 55 skeletally mature adolescent athletes who underwent UCL reconstruction between 2008 and 2010. Young athletes are throwing more often and throwing harder, which has shown to be predictive of injury risk, and subsequent surgery and is at least partly responsible for the rise in UCL reconstruction.^{16,25} The successful return from UCL reconstruction of well-known players in the major leagues contributes to the perceived invulnerability to career-ending injury in youth baseball culture. This is perpetuated by misconceptions of the indications, causation, and true outcomes of UCL reconstruction by players, parents, and even coaches.¹ This may further impair adherence to protective throwing guidelines shown to help reduce the risk of injury in youth players.^{3,27} The increasing numbers of UCL reconstructions in this study, especially within the younger age groups, support the need for prevention programs. However, it should be noted that the current study only reports an increase in the number of UCL reconstructions and, although inferred, not necessarily an increase in the number of UCL injuries. The advent of improved diagnostic modalities combined with recognition in the media has led to a heightened awareness of UCL injuries in the sports medicine community. This familiarity may be also be contributing to the procedure being more readily offered as a definitive treatment, particularly in the skeletally immature athlete.

When examining patient characteristics, male patients, who represented 90.5% of the study population, were nearly 12 times more likely to have a UCL reconstruction compared with female patients. This is consistent with previous studies that almost exclusively report on male baseball players, but a small percentage of other overhead athletes, including gymnasts, javelin throwers, tennis and football players, and wrestlers, is susceptible to UCL injury and undergoes reconstruction.³⁴ More interesting, patients with private insurance such as Blue Cross and of white race/ethnicity were much more likely to undergo UCL reconstruction than those with government insurance or of black and Hispanic race/ethnicity. Private payers were 25 times more likely to have a UCL reconstruction, while non-Hispanics were 11.4 times more likely compared with Hispanics. There are several plausible explanations for this observation, and this may represent a disparity in access to subspecialty care. The ability to undergo advanced imaging such as magnetic resonance imaging (MRI) or obtain physician appointments has been shown to be more difficult for individuals of lower socioeconomic status or of minority ethnicity.^{17,27,28} In addition, individuals of lower socioeconomic status participate in fewer sporting activities² and therefore may participate in fewer sports that risk UCL injury.

From 2002 to 2011, 69 distinct medical centers performed a UCL reconstruction. There was a significant trend in the number of medical centers performing UCL reconstruction, doubling from 10 centers in 2002 to 20 centers in 2011. A single institution was responsible for 145 UCL reconstructions (33.1%), while 51 other centers performed fewer than 5 total reconstructions over the 10-year study period. This increase in surgeons performing the operation may be partly explained by the heightened

awareness of physicians for UCL injury combined with enhanced diagnostic techniques that have improved the ability to diagnose medial elbow injuries. Yet, the low volume at the vast majority of the centers is concerning since the outcome of technically demanding orthopaedic procedures can be related to hospital volume.²⁰

We found a 400% increase in the number of concomitant ulnar nerve procedures performed at the time of UCL reconstruction. Ulnar nerve management during UCL reconstruction remains slightly controversial. The high rate of complications related to ulnar nerve symptoms with early reconstruction techniques led to the development of a muscle-splitting approach.³³ This allowed the avoidance of routine submuscular ulnar nerve transpositions, and additional modifications using a docking technique have further reduced the incidence of ulnar nerve neuropraxia.^{18,31} A systematic review by Vitale and Ahmad³⁴ reported that abandoning obligatory ulnar nerve transposition was associated with better outcomes, with a reduction in postoperative ulnar neuropathy from 9% to 4% and an increase in the rate of excellent outcomes from 75% to 89%. A more recent investigation by Watson et al³⁷ reported ulnar nerve complication rates ranging from 0% to 5% when authors use a docking technique and reserve ulnar nerve transportation only for those players with preoperative ulnar neuritis. The disproportionate increase in ulnar nerve procedures in our study contradicts the best available evidence guiding clinical practices. The rationale for this dramatic rise is likely multifactorial. The increase in the number of institutions now performing UCL reconstructions in New York State suggests the procedure is more widespread and perhaps performed by surgeons less familiar with the most recent evidence. Likewise, in the era of declining reimbursement, the addition of a procedural code to the operation provides a financial incentive for a concomitant ulnar nerve procedure.

Our study limitations include those inherent to administrative database studies. Although the accuracy of the SPARCS database has been previously examined,³⁰ small medical practitioner coding inaccuracies are possible and have been reported in the literature.²¹ The CPT-4 code for medial ulnar reconstruction with graft was introduced only after 2001, and a longer database history would have provided additional evidence for the study's significant findings. However, the CPT-4 code only documents outpatient procedures, and an associated ICD-9-CM code specific for UCL reconstruction performed on an inpatient basis does not exist within the SPARCS database. Therefore, it is possible that the UCL reconstruction frequencies may have been underreported. In contrast, the SPARCS database does not report mechanism of injury or specific patient characteristics that could confirm with absolute certainty that all UCL reconstructions occurred in overhead throwing athletes. It is possible that a small population of reconstructions occurred as a result of traumatic elbow dislocations or other non-throwing-related injuries. Last, the SPARCS database represents a single state record, and the patient, surgeon, and hospital-related factors may not reflect the entire US population. Geographic variation in sports participation among athletes is an

important consideration since UCL reconstruction is predominantly an injury of the throwing athlete. Despite these limitations, the SPARCS database with similar methods has been used to study numerous surgical procedures.^{6,11,19,20,32,35,36}

CONCLUSION

The frequency of UCL reconstruction is steadily rising in New York State and becoming more common in younger athletes. This trend may reflect widespread overuse in the adolescent throwers, and emphasis on public education to the risks of overuse throwing injuries and the importance of adhering to preventative guidelines is essential in youth baseball.

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