

2-13-2024

ChatGPT Can Offer Satisfactory Responses to Common Patient Questions Regarding Elbow Ulnar Collateral Ligament Reconstruction

William Johns
Thomas Jefferson University

Alec Kellish
Thomas Jefferson University

Dominic Farronato
Thomas Jefferson University

Michael G. Ciccotti
Thomas Jefferson University

Follow this and additional works at: https://jdc.jefferson.edu/rothman_institute



Sommer Hammoud
Part of Jefferson University's [Intelligence and Robotics Commons](#), [Sports Medicine Commons](#), and the [Surgery Commons](#)

[Let us know how access to this document benefits you](#)

Recommended Citation

Johns, William; Kellish, Alec; Farronato, Dominic; Ciccotti, Michael G.; and Hammoud, Sommer, "ChatGPT Can Offer Satisfactory Responses to Common Patient Questions Regarding Elbow Ulnar Collateral Ligament Reconstruction" (2024). *Rothman Institute Faculty Papers*. Paper 253.
https://jdc.jefferson.edu/rothman_institute/253

This Article is brought to you for free and open access by the Jefferson Digital Commons. The Jefferson Digital Commons is a service of Thomas Jefferson University's [Center for Teaching and Learning \(CTL\)](#). The Commons is a showcase for Jefferson books and journals, peer-reviewed scholarly publications, unique historical collections from the University archives, and teaching tools. The Jefferson Digital Commons allows researchers and interested readers anywhere in the world to learn about and keep up to date with Jefferson scholarship. This article has been accepted for inclusion in Rothman Institute Faculty Papers by an authorized administrator of the Jefferson Digital Commons. For more information, please contact: JeffersonDigitalCommons@jefferson.edu.

ChatGPT Can Offer Satisfactory Responses to Common Patient Questions Regarding Elbow Ulnar Collateral Ligament Reconstruction



William L. Johns, M.D., Alec Kellish, M.D., Dominic Farronato, B.S.,
Michael G. Ciccotti, M.D., and Sommer Hammoud, M.D.

Purpose: To determine whether ChatGPT effectively responds to 10 commonly asked questions concerning ulnar collateral ligament (UCL) reconstruction. **Methods:** A comprehensive list of 90 UCL reconstruction questions was initially created, with a final set of 10 “most commonly asked” questions ultimately selected. Questions were presented to ChatGPT and its response was documented. Responses were evaluated independently by 3 authors using an evidence-based methodology, resulting in a grading system categorized as follows: (1) excellent response not requiring clarification; (2) satisfactory requiring minimal clarification; (3) satisfactory requiring moderate clarification; and (4) unsatisfactory requiring substantial clarification. **Results:** Six of 10 ten responses were rated as “excellent” or “satisfactory.” Of those 6 responses, 2 were determined to be “excellent response not requiring clarification,” 3 were “satisfactory requiring minimal clarification,” and 1 was “satisfactory requiring moderate clarification.” Four questions encompassing inquiries about “What are the potential risks of UCL reconstruction surgery?” “Which type of graft should be used for my UCL reconstruction?” and “Should I have UCL reconstruction or repair?” were rated as “unsatisfactory requiring substantial clarification.” **Conclusions:** ChatGPT exhibited the potential to improve a patient’s basic understanding of UCL reconstruction and provided responses that were deemed satisfactory to excellent for 60% of the most commonly asked questions. For the other 40% of questions, ChatGPT gave unsatisfactory responses, primarily due to a lack of relevant details or the need for further explanation. **Clinical Relevance:** ChatGPT can assist in patient education regarding UCL reconstruction; however, its ability to appropriately answer more complex questions remains to be an area of skepticism and future improvement.

Artificial intelligence (AI) refers to the use of machines and computers to address problems and make decisions that traditionally have relied on human input.¹ In today’s society, AI-driven algorithms have become widespread, with examples such as Apple’s “Siri,” “Google Translate,” and even the original “Google Search.”² The field of orthopaedics also has witnessed an increase in AI implementation, with usage

increasing nearly 10-fold since 2010.³ Specifically, AI has been used in the radiographic assessment of fractures⁴ and osteoarthritis⁵ as well as developing preoperative outcome-prediction models for hip and shoulder arthroplasty.^{6,7} In sports medicine, AI models have shown promise by accurately recognizing meniscal injuries or anterior cruciate ligament tears on magnetic resonance imaging, with diagnostic accuracy ranging between 75% and 100%.⁸

ChatGPT, a more recent rendition of AI-driven algorithms developed by OpenAI, is a free and publicly available AI natural language program that attempts to answer a wide range of questions through supervised and reinforced learning with human feedback. Following its launch in November 2022, ChatGPT has gained immense popularity, attaining more than 1 million users within 5 days of open testing, attracting 1.6 billion website visits, and greater than 100 million monthly active users within 3 months of availability.⁹ This widespread adoption of ChatGPT has sparked a notable surge in research publications exploring its

From the Rothman Orthopaedic Institute at Thomas Jefferson University, Philadelphia, Pennsylvania, U.S.A. (W.L.J., A.K., M.G.C., S.H.); and Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, Pennsylvania, U.S.A. (D.F.).

Received August 25, 2023; accepted January 8, 2024.

Address correspondence to Sommer Hammoud, M.D., Department of Orthopaedic Surgery at The Rothman Institute at Thomas Jefferson University. E-mail: Sommer.Hammoud@rothmanortho.com

© 2024 THE AUTHORS. Published by Elsevier Inc. on behalf of the Arthroscopy Association of North America. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).
2666-061X/231187

<https://doi.org/10.1016/j.asmr.2024.100893>

potential utility within the field of orthopaedic surgery, both in the academic and clinical sectors.¹⁰⁻¹² One such study by Mika et al.¹³ focused on the potential role of ChatGPT in answering frequently asked questions pertaining to total hip arthroplasty, finding that ChatGPT was capable of providing responses that require only minimal or moderate clarification, and concluding that the ChatBot “has the potential to act as a patient-education adjunct.”

The integration of AI-based educational materials into patient care has shown promising results in improving shared decision-making, patient satisfaction, and post-operative functional outcomes for select orthopaedic procedures.¹⁴ Patients undergoing ulnar collateral ligament (UCL) reconstruction face a multitude of information and choices, including graft options, surgical techniques, nonoperative treatments, and postoperative rehabilitation strategies. These decisions, combined with the significant number of general misperceptions of this injury and the pressure to return to sports at a preinjury level of performance,¹⁵ often contribute to heightened patient stress and anxiety. In this context, employing AI technology for patient education could prove beneficial in facilitating shared decision-making and providing comprehensive information to those considering UCL reconstruction. Therefore, the purpose of this study was to determine whether ChatGPT effectively responds to 10 commonly asked questions concerning UCL reconstruction. We hypothesized that ChatGPT would offer acceptable answers to basic questions patients may have about UCL reconstruction.

Methods

Mirroring the methodology of a similar study by Mika et al.,¹³ this study involved the compilation of data from the “Frequently Asked Questions” sections of 14 reputable health care institutions of providers’ websites. A comprehensive list of 90 total UCL-related questions was made. Subsequently, a thorough review of all questions was conducted, leading to the consensus on a final list of 10 questions that the authors believed were most encountered within the clinical setting and deemed highly relevant. To assess the AI ChatBot’s performance, each of the finalized 10 questions was presented to ChatGPT (Version 3.5) using its freely accessible online interface (<http://chat.openai.com/chat>)¹⁶ on July 18, 2023. The ChatGPT’s responses to these queries were then evaluated to gauge its effectiveness in addressing the proposed questions.

ChatGPT responses were precisely documented after the initial query with no additional follow-up questions conducted during each query. To evaluate the accuracy of the AI system’s responses, 3 different authors (W.L.J., A.K., D.F.) graded each response using an evidence-based approach, using a rating system introduced by Mika et al. (Table 1).¹³ The average grade for each response was then reported and inter-rater

Table 1. ChatGPT Response Rating System

Response Accuracy Score	Accuracy Description
1	Excellent response not requiring classification
2	Satisfactory requiring minimal clarification
3	Satisfactory requiring moderate clarification
4	Unsatisfactory requiring substantial clarification

reliability was calculated using intraclass correlation coefficients. The grading system encompassed 4 distinct categories as follows:

1. “Excellent response not requiring clarification”: The answer was deemed to be highly accurate and comprehensive, providing information without the need for further clarification.
2. “Satisfactory requiring minimal clarification”: The answer was considered accurate; however, it required minimal additional clarification to address the user’s question.
3. “Satisfactory requiring moderate clarification”: The answer was still accurate, but it necessitated a moderate level of further clarification to meet the user’s needs.
4. “Unsatisfactory requiring substantial clarification”: The answer was deemed to contain significantly inaccurate information or was overly generalized, potentially leading to misunderstanding by the user.

The readability of ChatGPT responses was assessed using the WordCalc software, in which the responses to each question were pasted into the readability calculator and the corresponding Flesch–Kincaid Grade Level was recorded.^{17,18} This study did not require institutional review board approval.

Results

Response Quality Assessment and Readability

The average Flesch–Kincaid reading or education level required to fully understand ChatGPT responses was 11.51 when averaged across all response. This equates to the reading level of a high-school senior. The mean score of responses generated by ChatGPT using the grading scale by Mika et al. was 3, with an intraclass correlation coefficient of 0.956, indicating that responses were generally satisfactory but required moderate clarification (Table 2).

Analysis

Presented to follow are the responses provided by ChatGPT in relation to the 10 UCL reconstruction-related patient questions as input by the authors. Each question is followed by its corresponding ChatGPT response, accompanied by an analysis by the authors critiquing the accuracy and adequacy of the answer.

Table 2. Assessment of ChatGPT Responses and Reading Level

Question	Mean Mika et al. Score	Flesch–Kincaid Reading Level Assessment
What are the nonsurgical treatment options for a UCL tear?	2	12
Should I have a UCL reconstruction or repair?	4	10.2
What is done during a UCL reconstruction surgery?	3.3	12
What are the options for UCL reconstruction and which technique is superior?	1	12
Which type of graft should be used for my UCL reconstruction?	4	11.5
What is the success rate of UCL reconstruction and how often can pitchers return to baseball after surgery?	2	12
What are the potential risks of UCL reconstruction surgery?	4	12
How long will it take to fully recover from UCL reconstruction surgery?	2	12
Can I retear my UCL after surgery?	1.3	12
Does Tommy John surgery improve pitching velocity or performance?	4	9.4
Means	3	12

NOTE. Each mean was rounded to the nearest whole number. UCL, ulnar collateral ligament.

Question 1: What are the nonsurgical treatment options for a UCL tear?

ChatGPT Response: “Nonsurgical treatment options for a UCL tear include rest, ice application, compression with a bandage or brace, physical therapy to strengthen surrounding muscles, and improve flexibility, over-the-counter anti-inflammatory medications, platelet-rich plasma (PRP) injections, prolotherapy, ultrasound therapy, and electrical stimulation. These options are typically considered for partial tears when surgery is not immediately required. However, the effectiveness of these treatments depends on the severity of the tear and individual patient factors. If nonsurgical methods do not provide relief or for severe cases, surgical intervention may be necessary.”

Analysis: Satisfactory Response Requiring Minimal Clarification

The ChatGPT response regarding the nonsurgical treatment options for a UCL tear adequately provides potential management and treatment options used in the treatment of these injuries. However, the response falls short regarding the likelihood of successful treatment, return to play, and return to sport, and also fails to include the advantages and disadvantages of these treatment options. Nonoperative management is typically reserved for patients with low-grade partial tears, short duration of symptoms, no previous trials of nonoperative intervention, and/or inability to comply with an extensive rehabilitation program.¹⁹ Return to play following nonoperative management varies widely, with reports ranging from 42% to 93%, with large heterogeneity between cohorts.²⁰⁻²² Multiple factors play a role in the successful nonoperative management of UCL tears, most importantly, the grade and location of the tear with low-grade and proximal tears having greater rates of return to play than high-grade and distal tears.²³

Physical therapy is a mainstay of treatment in patients being managed both nonoperatively and operatively with UCL reconstruction. In nonoperative patients, the physical therapy regimen has 3 main phases beginning with inflammation reduction and improving range of motion at the elbow followed by restoring muscular endurance and strength, and ultimately returning to sport with sport-specific throwing protocols.^{20,24} Throughout these phases, the physical therapist will use a multitude of modalities, including ultrasonography and electrostimulation, in conjunction with exercises and stretching.^{20,24} Throwing athletes also are restricted from throwing for approximately 3 months during this time.²⁰

PRP injection also may be used, with current literature supporting the use of PRP in patients with low-grade and proximal tears.^{20,21,25-27} However, the rate of return to play in nonoperative patients who receive PRP injections remains low, with greater rates associated with younger patient age, shorter time from injury to injection, and patient skill level.²¹⁻²³

Question 2: Should I have a UCL reconstruction or repair?

ChatGPT Response: “The decision between UCL reconstruction and repair depends on the severity of the tear and the patient’s activity level. UCL repair is suitable for partial tears or minor damage, with faster recovery but a higher retear risk. UCL reconstruction is recommended for severe tears or high-demand athletes, with a longer recovery time.”

Analysis: Unsatisfactory Response Requiring Substantial Clarification

The ChatBot accurately highlights the potential for faster recovery and return to sport after UCL repair.²⁸ However, the response greatly oversimplified the multitude of factors that must be considered and

discussed in a shared decision-making process between patient and surgeon when deciding between UCL reconstruction and repair. A contemporary UCL Consensus Statement highlighted 90% consensus for the following UCL repair indications: partial-thickness tears, isolated avulsion-type tears of the proximal or distal aspect of the ligament—particularly acute, absence of chronic ligamentous changes, and patient preference if both surgical techniques are an option.¹⁹

Additionally, the ChatBot response is misleading in suggesting that lower-demand athletes may be better suited for repair as opposed to reconstruction for high-demand athletes. Furthermore, the source of the “higher retear risk” with repair cited by the ChatBot is of unclear origin and may instead be referring to the poor functional outcomes of early repair in Major League Baseball pitchers demonstrated by Conway et al. in 1992.²⁹ This response likely does not account for more contemporary biomechanical reports favoring repair,^{30,31} and promising clinical outcomes that have been reported as repair techniques have evolved.³² Ultimately, such response from the ChatBot fails to accurately convey the complexities of such decision of UCL repair versus UCL reconstruction and further offers potential to mislead or misinform users.

Question 3: What is done during a UCL reconstruction surgery?

ChatGPT Response: “During UCL reconstruction surgery, the damaged UCL in the elbow is replaced with a tendon graft. The surgeon creates tunnels in the bones to accommodate the graft, secure it in place, and then the patient undergoes a rehabilitation program for several months to regain strength and function.”

Analysis: Satisfactory Response Requiring Moderate Clarification

The ChatBot correctly provides a brief overview of the overall premise of UCL reconstructive surgery that is likely sufficient for a common user. However, the response does not address the need for autograft tendon harvest, which is used far more commonly than allografts and must either be harvested from the palmaris or the hamstring.³³ Furthermore, some UCL reconstruction techniques or clinical scenarios necessitate either ulnar nerve transposition or decompression,³⁴ which is not considered in this response. As both of these entities necessitate an additional surgical incision, operating room time, and risk of complications^{35,36} (see analysis of Question 8 for further discussion), the response from the ChatBot is incomplete.

Question 4: What are the options for UCL reconstruction and which technique is superior?

ChatGPT Response: “As of my last update in September 2021, there is no clear superiority between the Docking

and Modified Jobe (Tommy John) techniques for UCL reconstruction. One approach involves internal brace augmentation, where synthetic or nonbiological material is used to provide additional stability during healing. The docking technique is a modified approach that secures the graft to bone tunnels without additional fixation devices. Lastly, double-bundle reconstruction uses 2 grafts to replicate the two separate bundles of the original UCL, aiming to improve the ligament’s natural function. For graft choice, both the palmaris longus and hamstring autograft techniques have shown positive outcomes in reconstruction surgery. The choice of technique depends on the surgeon’s experience and the patient’s specific condition and needs.”

Analysis: Excellent Response Not Requiring Clarification

Despite a 2-year lag in updated literature on the topic, the ChatBot correctly highlights that there has not been consistent superiority demonstrated between the most commonly employed techniques in UCL reconstruction—especially the docking and modified Jobe techniques.³⁷ The existing body of published literature suggests that techniques with modern muscle-sparing approaches do not significantly differ with respect to overall complications, nerve-specific complications, time to return to sport, or performance quality upon return.^{37,38} Biomechanical reports suggest that the modified Jobe and docking techniques both provide comparable valgus stability to that of the native UCL, whereas others report superiority in strain and maximal moments to failure with the docking technique, although such reports have not clearly manifested clinically.^{39,40} Perhaps most importantly, the ChatBot astutely highlights that consideration of UCL reconstruction technique should strongly consider the surgeon’s own experience and preference toward a given technique.

Question 5: Which type of graft should be used for my UCL reconstruction?

Chat GPT Response: “The graft choice for reconstruction depends on factors like the surgeon’s expertise, patient’s age, activity level, and graft availability. Common options include palmaris longus tendon, hamstring tendons, patellar tendon (autografts), cadaver tendons (allografts), or synthetic grafts. Each graft option has its advantages and potential drawbacks, and the choice depends on various factors. As of my last update in September 2021, there is no definitive evidence to suggest that one graft type is consistently superior to all other graft options.”

Analysis: Unsatisfactory Response Requiring Substantial Clarification

The ChatGPT response to this question incorrectly suggests that patellar tendon grafts are used for UCL

reconstruction and provides very limited information regarding the advantages and disadvantages of each graft source. In addition, although there is a plethora of graft options at the surgeon's disposal, ChatGPT does not highlight that the most common selection is the palmaris longus autograft. Palmaris longus is used in more than 50% to 74% of UCL reconstructions, with the next most common graft used being gracilis autograft.^{41,42} The rate of return to play and level of performance does not appear to be significantly affected by autograft selection of hamstring or palmaris⁴¹ and even the use of hamstring allograft has yielded favorable results in overhead throwing athletes.⁴³

In addition, ChatGPT does not highlight recent trends toward the use of hamstring autografts among elite baseball players⁴² and provides no further consideration of factors such as laterality of the graft harvest site. Although 72.5% of major league baseball team physicians performing UCL with hamstring autografts prefer the contralateral/landing leg primarily based on electromyographic study findings,^{33,44} it has not been clearly demonstrated that such preferences result in an improved rate of return to play, performance, or subsequent rate of injury.⁴⁵

Lastly, although ChatGPT states there are advantages and disadvantages between graft choices, it provides only a limited response and does not provide further insight into specific considerations such as the location of surgical incisions, operating room time, potential surgical-site infections, muscle weakness, or inadvertent median nerve harvest, which the patient must be made aware of before UCL reconstruction.

Question 6: What is the success rate of UCL reconstruction and how often can pitchers return to baseball after surgery?

ChatGPT Response: "The success rate of pitchers returning to play baseball is generally high, with rates ranging from 80% to 90%. Recovery takes about 12-18 months, and success depends on various factors such as age, health, injury severity, and adherence to rehabilitation. Although many pitchers return to play at their preinjury level, some may experience changes in performance or need more time to return to their previous performance level."

Analysis: Satisfactory Response Requiring Minimal Clarification

In this response, ChatGPT accurately reports the rate of return to play, specifically in pitchers, exceeds 80%. However, the response does not provide further clarification that while the rate of return to play may be high, the rate of returning to the same level is likely lower, with Thomas et al.⁴⁶ reporting that return to the same level of play was as low as 67%. In addition, an important impact of UCL reconstruction specifically in

pitchers that is not described by ChatGPT is that many pitchers had decreased workloads and a varying degree of fastball use postoperatively, especially in the first year following surgery.^{46,47}

Question 7: What are the potential risks of UCL reconstruction surgery?

ChatGPT Response: "Risks include infection, graft failure, nerve or blood vessel injury, stiffness, persistent pain, loss of strength, delayed recovery, blood clots, anesthesia complications, and allergic reactions. While most patients have positive outcomes, discussing these risks with the surgeon is essential."

Analysis: Unsatisfactory Response Requiring Substantial Clarification

The response provided by ChatGPT is ultimately too vague of a response, failing to include potential complications, such as perioperative fracture and hardware failure. Furthermore, ChatGPT fails to provide statistical data regarding the rate of complications themselves, a crucial piece of information when patients are considering surgical intervention for the treatment of their UCL injury, or factors impacting rates of complication. The response also does not provide insight into the potential management of such complications, with several complications requiring a return to the operating room for an additional surgical procedure. Lastly, the description provided of "nerve injury" lacks clarity, as the spectrum of nerve injury can vary from complete loss of function of the ulnar nerve to transient paresthesia following UCL reconstruction.

The rate of complications following UCL reconstruction is approximately 5% to 18%.^{38,48,49} The most common complication following UCL reconstruction includes ulnar nerve paresthesia/neuropathia (8%-74%), superficial surgical-site infection from graft harvest site (4%), graft failure (1%), and need for revision UCL reconstruction (1%-15%).^{41,48-50} In addition, the rate of reported reoperation, excluding revision UCL reconstruction, due to complications approaches 5%, most commonly due to excision of heterotopic ossification. This information is critical to the informed discussion a surgeon must have with his/her patient preoperatively to ensure they adequately understand the potential risks, and the likelihood of such risks, before surgery.⁵¹

Question 8: How long will it take to fully recover from UCL reconstruction surgery?

ChatGPT Response: "The recovery for UCL reconstruction can take several months to a year. The stages of recovery include initial post-surgery healing, weeks 1-6 focused on gentle mobility exercises, weeks 6-12 emphasizing elbow strength and flexibility, months 3-6 with progressive strengthening, and months 6-12

focused on functional activities and sports-specific training. It may take up to a year or more for athletes to fully recover and return to high-level activities. Close adherence to the prescribed rehabilitation plan is crucial for optimal outcomes.”

Analysis: Satisfactory Response Requiring Minimal Clarification

The ChatGPT response accurately provides an average postoperative rehabilitation protocol timeline following UCL reconstruction. In addition, ChatGPT accurately indicates it can take athletes longer than 1 year to recover from the UCL reconstruction and return to their sport. Current literature supports a 4-phase rehabilitation program^{42,52}:

- Phase 1, the immediate postoperative period of 0 to 3 weeks: Focuses on gentle range of motion while allowing the graft to heal while minimizing stiffness. During this phase, patients are restricted to a brace limiting their range of motion, with stepwise increases each week in their allowed range of motion over 3 weeks.
- Phase 2, postoperative weeks 4 to 8: Increasing motion to achieve full range of motion following the discontinuation of the brace.
- Phase 3, postoperative weeks 8 to 12: Introduction of strengthening exercises to recover strength, power, and muscular endurance. The exercises used during this period vary but primarily consist of grip strengthening, isometric/isotonic strengthening, and rotator cuff strengthening.⁵³
- Phase 4, postoperative weeks 12 to 32: Return-to-play protocols with sports-specific rehabilitation schemes.

The “Interval Throwing Program” and the “Thrower’s Ten Program” are commonly used during the rehabilitation process and are often initiated in the transition from phase 3 to phase 4 of the rehabilitation timeline. In a systematic review by Kemler et al.,⁵⁴ the “Thrower’s Ten Program” was initiated at a mean of 7 weeks postoperatively, and phase 1 of the “Interval Throwing Program” began at a mean of 16 weeks. The average return to sport is variable with return to sport ranging from as early as 6.5 months to exceeding 20 months postoperatively, with longer return-to-play times found in Major League Baseball pitchers.⁵⁴ Conditional return to sport requires normal strength in the extremity, balanced and coordinated throwing motions, and remaining pain-free during the activity.^{29,55} Once an athlete has returned to sport, the current literature does not support specific restrictions in innings pitched, the number of pitches thrown, or games played with regards to injury prevention.^{56,57}

Question 9: Can I retear my UCL after surgery?

ChatGPT Response: “Yes, it is possible to retear to UCL after reconstruction surgery. Factors that can contribute

to retearing include a premature return to activities, overuse or high-impact activities, poor rehabilitation compliance, improper mechanics, and traumatic events. Following the rehabilitation plan, a gradual return to activities, and proper mechanics can help reduce the risk of retearing.”

Analysis: Satisfactory Response Requiring Minimal Clarification

The ChatGPT response regarding retear of the UCL after reconstruction is an accurate and concise statement. The current rate of retear after a UCL reconstruction is reported to range from 1% to 15% depending on the sport of the athlete undergoing the reconstruction,^{36,58-60} which the ChatBot should report as this is imperative for athletes to understand preoperatively. Pitchers are at significantly greater risk for reinjury requiring revision UCL reconstruction (5%-15%) compared with nonpitching overhead athletes (i.e., baseball position players, javelin throwers; 1%-2%). In patients requiring revision UCL reconstruction, the time to reinjury is variable, ranging from 1 to 13 years, with an average time to reinjury of 5 years.⁶⁰⁻⁶² Following reinjury after UCL reconstruction, patients requiring revision UCL reconstruction demonstrate substantially lower rates of return to sport at any level (46%-85%) and return to sport at their previous competitive level (33%-78%) compared with primary UCL reconstruction.^{58-60,63}

Question 10: Does Tommy John surgery improve pitching velocity or performance?

ChatGPT Response: “The surgery aims to stabilize the elbow joint and enable pitchers to return to their pre-injury level of play. While some pitchers may experience improved pitching velocity, it’s not guaranteed for everyone. Factors such as age, skill level, rehabilitation, and mechanics play roles in postsurgery outcomes. The surgeon’s primary goal is to allow pitchers to continue their careers without pain or recurrent injuries.”

Analysis: Unsatisfactory Requiring Substantial Clarification

The response provided by ChatGPT regarding pitching velocity and performance following UCL reconstruction is not a sufficient response, as it provides information that is not accurate and is too limited with respect to postoperative performance. The response by ChatGPT indicates that patients may experience improvements but does not consider that players may only be able to reach their preinjury baseline or have significantly worse function postoperatively. The potential negative impacts of UCL injury requiring reconstruction on pitching performance including fastball accuracy, decreased innings pitched per season, wins per season, walks plus hits per inning pitched (i.e., WHIP), and

pitches in the strike zone with increased earned-run average and opponent batting averages have been well-described.⁶⁴⁻⁶⁶ In contrast, there are also reports of increased fastball velocity and complete return to baseline pitching performance following UCL reconstruction,⁶⁷ and Keller et al.⁵⁶ highlighted maintained pitching workload and performance with improved earned-run average beginning in the second post-operative season compared with preoperatively. Thus, in light of conflicting evidence with regards to post-operative sport-related performance, appropriate patient counseling before UCL reconstruction is imperative and the implication of the ChatGPT response suggesting that all patients will experience an improvement in their performance is likely misleading.

Discussion

ChatGPT was able to provide satisfactory or excellent responses to 6 of 10 of the frequently asked questions following UCL reconstruction; however, the other 4 responses were deemed unsatisfactory due to lack of detail and oversimplifications. ChatGPT can assist in patient education regarding UCL reconstruction; however, its ability to appropriately answer more complex questions remains to be an area of skepticism and future improvement.

The emergence and widespread utility of ChatGPT offers immense opportunities for information sharing and delivery of AI-generated responses to the general public free of charge and in a timely manner. Such technology will undoubtedly catalyze the ongoing infusion of AI into the field of orthopaedics, particularly in the realm of perioperative patient education. Our primary aim was to evaluate the utility of ChatGPT as a perioperative supplement to patient education regarding UCL reconstruction. In the cohort of patients undergoing UCL reconstruction, whose playing career and sometimes future financial opportunities are in jeopardy, the breadth of information and decisions to consider regarding surgical technique, graft options, graft source, as well as rehabilitation plans, and future performance can all serve as major stressors. The potential role for AI-inspired perioperative patient education, particularly for this population, is promising and in a cohort of patients with knee osteoarthritis considering total knee arthroplasty, Jayakumar et al.¹⁴ asserted that incorporation of AI into patient decision-making regarding surgery resulted in improved functional outcomes, patient satisfaction, and level of shared decision-making.

Ultimately, ChatGPT was able to provide satisfactory or excellent responses requiring minimal-to-moderate clarification to 6 of 10 frequently asked questions following UCL reconstruction, suggesting that this widely available technology has the potential to serve as a valuable supplement to patient education. However, 4

of 10 responses were deemed “unsatisfactory,” primarily due to lack of granularity with the response of the ChatBot or oversimplifications of explanations (i.e., discussion of surgical risks, realistic expectations for postoperative outcomes), which could prove misleading to a vulnerable consumer without further clarification. Although ChatGPT offers promising technology with the immense capability of affording in-depth medical knowledge to a broad audience with the capacity for iterative learning, expectations and reliance on such innovation in its current form should be met with healthy skepticism and careful consideration.

Limitations

This study is not without limitations. First and foremost, the evaluations of responses given by ChatGPT by each author was subjective. To limit subjective differences and bias, each author was blinded from one another’s evaluations, and each response evaluation was an average of each author’s assigned scoring. Second, ChatGPT is a rapidly growing AI server that will presumably improve in the future. For this study, the free version 3.5 was used, as it was assumed most patients would also use this version. There already exists a newer 4.0 version, ChatGPT’s smartest and most capable model, that requires a paid subscription, which may have given slightly different responses. As ChatGPT further evolves in the future, its responses may be able to provide more intricate details further assisting in patient education. In addition, ChatGPT responses were limited to one paragraph, and no follow-up questions or repeat queries were performed. This was done intentionally for the purposes of manuscript preparation and presentation; however, this may not accurately represent the application of ChatGPT by prospective patients. Further study on the ChatGPT utilization practices of patients is necessary.

Conclusions

ChatGPT exhibited the potential to improve a patient’s basic understanding of UCL reconstruction and provided responses that were deemed satisfactory to excellent for 60% of the most commonly asked questions. For the other 40% of questions, ChatGPT gave unsatisfactory responses, primarily due to a lack of relevant details or the need for further explanation.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work the authors used ChatGPT Open AI in order to obtain answers to questions that were queried into its server in order to evaluate the systems effectiveness. After using this tool/

service, the authors reviewed content as needed, however, responses were not edited, as the purpose of this study was to evaluate ChatGPT's effectiveness in the first place as explained in the paper. The authors take full responsibility for the content of the publication.

Disclosure

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: M.G.C. reports board or committee member, American Orthopaedic Society for Sports Medicine, Major League Baseball Team Physicians Association, and Orthopaedic Learning Center, outside the submitted work. S.H. reports board or committee member, American Orthopaedic Society for Sports Medicine, Orthopaedic Learning Center, and Perry Initiative, outside the submitted work; and paid consultant, Arthrex, outside the submitted work. All other authors (W.L.J., A.K., D.F.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

References

- McCarthy J, Minsky M, Rochester N, Shannon C. A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence. Published online August 31, 1955. <https://ojs.aaai.org/aimagazine/index.php/aimagazine/article/view/1904>. Accessed August 4, 2023
- Kurmis AP, Ianunzio JR. Artificial intelligence in orthopedic surgery: Evolution, current state and future directions. *Arthroplasty* 2022;4:9.
- Cabitz F, Locoro A, Banfi G. Machine learning in orthopedics: A literature review. *Front Bioeng Biotechnol* 2018;6:75.
- Al-Helo S, Alomari RS, Ghosh S, et al. Compression fracture diagnosis in lumbar: A clinical CAD system. *Int J Comput Assist Radiol Surg* 2013;8:461-469.
- Ashinsky BG, Bouhrara M, Coletta CE, et al. Predicting early symptomatic osteoarthritis in the human knee using machine learning classification of magnetic resonance images from the osteoarthritis initiative: Machine learning classification of knee MRIs. *J Orthop Res* 2017;35:2243-2250.
- Karhade AV, Schwab JH, Bedair HS. Development of machine learning algorithms for prediction of sustained postoperative opioid prescriptions after total hip arthroplasty. *Arthroplasty* 2019;34:2272-2277.e1.
- Karnuta JM, Churchill JL, Haeberle HS, et al. The value of artificial neural networks for predicting length of stay, discharge disposition, and inpatient costs after anatomic and reverse shoulder arthroplasty. *J Shoulder Elbow Surg* 2020;29:2385-2394.
- Kunze KN, Rossi DM, White GM, et al. Diagnostic performance of artificial intelligence for detection of anterior cruciate ligament and meniscus tears: A systematic review. *Arthroscopy* 2021;37:771-781.
- Duarte F. Number of ChatGPT Users (2023). <https://explodingtopics.com/blog/chatgpt-users#:~:text=According%20to%20the%20latest%20available,has%20over%20100%20million%20users>. Accessed August 4, 2023.
- Fayed AM, Mansur NSB, De Carvalho KA, Behrens A, D'Hooghe P, De Cesar Netto C. Artificial intelligence and ChatGPT in orthopaedics and sports medicine. *J Exp Orthop* 2023;10:74.
- Bernstein J. Not the last word: ChatGPT can't perform orthopaedic surgery. *Clin Orthop Relat Res* 2023;481:651-655.
- Gilat R, Cole BJ. How will artificial intelligence affect scientific writing, reviewing and editing? the future is here *Arthroscopy* 2023;39:1119-1120.
- Mika AP, Martin JR, Engstrom SM, Polkowski GG, Wilson JM. Assessing ChatGPT responses to common patient questions regarding total hip arthroplasty. *J Bone Joint Surg* 2023;105:1519-1526.
- Jayakumar P, Moore MG, Furlough KA, et al. Comparison of an artificial intelligence-enabled patient decision aid vs educational material on decision quality, shared decision-making, patient experience, and functional outcomes in adults with knee osteoarthritis: A randomized clinical trial. *JAMA Netw Open* 2021;4:e2037107.
- Ahmad CS, Grantham WJ, Greiwe RM. Public perceptions of Tommy John surgery. *Phys Sportsmed* 2012;40:64-72.
- OpenAI. <https://chat.openai.com/chat>. Accessed July 18, 2023.
- Readability Calculator. https://www.wordcalc.com/readability/#google_vignette. Accessed December 13, 2023.
- Badarudeen S, Sabharwal S. Assessing readability of patient education materials: Current role in orthopaedics. *Clin Orthop Relat Res* 2010;468:2572-2580.
- Erickson BJ, Hurley ET, Mojica ES, et al. Elbow ulnar collateral ligament tears: A modified consensus statement. *Arthroscopy* 2023;39:1161-1171.
- Rettig AC, Sherrill C, Snead DS, Mendler JC, Mieling P. Nonoperative treatment of ulnar collateral ligament injuries in throwing athletes. *Am J Sports Med* 2001;29:15-17.
- Chauhan A, McQueen P, Chalmers PN, et al. Nonoperative treatment of elbow ulnar collateral ligament injuries with and without platelet-rich plasma in professional baseball players: A comparative and matched cohort analysis. *Am J Sports Med* 2019;47:3107-3119.
- Ford GM, Genuario J, Kinkartz J, Githens T, Noonan T. Return-to-play outcomes in professional baseball players after medial ulnar collateral ligament injuries: Comparison of operative versus nonoperative treatment based on magnetic resonance imaging findings. *Am J Sports Med* 2016;44:723-728.
- Frangiamore SJ, Lynch TS, Vaughn MD, et al. Magnetic resonance imaging predictors of failure in the nonoperative management of ulnar collateral ligament injuries in professional baseball pitchers. *Am J Sports Med* 2017;45:1783-1789.
- Swindell HW, Trofa DP, Alexander FJ, Sonnenfeld JJ, Saltzman BM, Ahmad CS. Nonsurgical management of

- ulnar collateral ligament injuries. *J Am Acad Orthop Surg Glob Res Rev* 2021;5:e20.00257.
25. Deal JB, Smith E, Heard W, O'Brien MJ, Savoie FH. Platelet-rich plasma for primary treatment of partial ulnar collateral ligament tears: MRI correlation with results. *Orthop J Sports Med* 2017;5:2325967117738238.
 26. Dines JS, Williams PN, ElAttrache N, et al. Platelet-rich plasma can be used to successfully treat elbow ulnar collateral ligament insufficiency in high-level throwers. *Am J Orthop (Belle Mead NJ)* 2016;45:296-300.
 27. Podesta L, Crow SA, Volkmer D, Bert T, Yocum LA. Treatment of partial ulnar collateral ligament tears in the elbow with platelet-rich plasma. *Am J Sports Med* 2013;41:1689-1694.
 28. Erickson BJ, Bach BR, Verma NN, Bush-Joseph CA, Romeo AA. Treatment of ulnar collateral ligament tears of the elbow: Is repair a viable option? *Orthop J Sports Med* 2017;5:232596711668221.
 29. Conway JE, Jobe FW, Glousman RE, Pink M. Medial instability of the elbow in throwing athletes. Treatment by repair or reconstruction of the ulnar collateral ligament. *J Bone Joint Surg Am* 1992;74:67-83.
 30. Torres SJ, Limpisvasti O. Ulnar collateral ligament repair of the elbow—biomechanics, indications, and outcomes. *Curr Rev Musculoskelet Med* 2021;14:168-173.
 31. Dugas JR, Walters BL, Beason DP, Fleisig GS, Chronister JE. Biomechanical comparison of ulnar collateral ligament repair with internal bracing versus modified Jobe reconstruction. *Am J Sports Med* 2016;44:735-741.
 32. Dugas JR, Looze CA, Capogna B, et al. Ulnar collateral ligament repair with collagen-dipped FiberTape augmentation in overhead-throwing athletes. *Am J Sports Med* 2019;47:1096-1102.
 33. Erickson BJ, Chalmers PN, Dugas JR, et al. Do Major League Baseball team physicians harvest the semitendinosus from the drive leg or landing leg when performing ulnar collateral ligament reconstruction on elite baseball pitchers? *Orthop J Sports Med* 2017;5:232596711771398.
 34. Azar FM, Andrews JR, Wilk KE, Groh D. Operative treatment of ulnar collateral ligament injuries of the elbow in athletes. *Am J Sports Med* 2000;28:16-23.
 35. Vitale MA, Ahmad CS. The outcome of elbow ulnar collateral ligament reconstruction in overhead athletes: A systematic review. *Am J Sports Med* 2008;36:1193-1205.
 36. Cain EL, Andrews JR, Dugas JR, et al. Outcome of ulnar collateral ligament reconstruction of the elbow in 1281 athletes: Results in 743 athletes with minimum 2-year follow-up. *Am J Sports Med* 2010;38:2426-2434.
 37. Looney AM, Wang DX, Conroy CM, et al. Modified Jobe versus Docking technique for elbow ulnar collateral ligament reconstruction: A systematic review and meta-analysis of clinical outcomes. *Am J Sports Med* 2021;49:236-248.
 38. Looney AM, Fackler NP, Pianka MA, et al. No difference in complications between elbow ulnar collateral ligament reconstruction with the Docking and modified Jobe techniques: A systematic review and meta-analysis. *Am J Sports Med* 2022;50:2324-2338.
 39. Ciccotti MG, Siegler S, Kuri JA, Thinnnes JH, Murphy DJ. Comparison of the biomechanical profile of the intact ulnar collateral ligament with the modified Jobe and the Docking reconstructed elbow: An in vitro study. *Am J Sports Med* 2009;37:974-981.
 40. Paletta GA, Klepps SJ, Difelice GS, et al. Biomechanical evaluation of 2 techniques for ulnar collateral ligament reconstruction of the elbow. *Am J Sports Med* 2006;34:1599-1603.
 41. Griffith TB, Ahmad CS, Gorroochurn P, et al. Comparison of outcomes based on graft type and tunnel configuration for primary ulnar collateral ligament reconstruction in professional baseball pitchers. *Am J Sports Med* 2019;47:1103-1110.
 42. Erickson BJ, Harris JD, Chalmers PN, et al. Ulnar collateral ligament reconstruction. *Sports Health* 2015;7:511-517.
 43. Savoie FH, Morgan C, Yaste J, Hurt J, Field L. Medial ulnar collateral ligament reconstruction using hamstring allograft in overhead throwing athletes. *J Bone Joint Surg* 2013;95:1062-1066.
 44. Erickson BJ, Zaferiou A, Chalmers PN, et al. Are the hamstrings from the drive leg or landing leg more active in baseball pitchers? An electromyographic study. *J Shoulder Elbow Surg* 2017;26:2010-2016.
 45. Erickson BJ, Chalmers PN, D'Angelo J, et al. Side of hamstring harvest does not affect performance, return-to-sport rate, or future hamstring injuries after ulnar collateral ligament reconstruction among professional baseball pitchers. *Am J Sports Med* 2019;47:1111-1116.
 46. Thomas SJ, Paul RW, Rosen AB, et al. Return-to-play and competitive outcomes after ulnar collateral ligament reconstruction among baseball players: A systematic review. *Orthop J Sports Med* 2020;8:2325967120966310.
 47. Marshall NE, Keller RA, Limpisvasti O, ElAttrache NS. Pitching performance after ulnar collateral ligament reconstruction at a single institution in major league baseball pitchers. *Am J Sports Med* 2018;46:3245-3253.
 48. Boksh K, Mishra P, Akram N, Abdolrazaghi S, Singh H. Medial ulnar collateral ligament repair with augmentation: A systematic review and meta-analysis of preclinical studies. *Orthop J Sports Med* 2023;11:23259671231158373.
 49. Rothermich MA, Fleisig GS, Lucas HE, et al. Early complications of ulnar collateral ligament repair with collagen-coated suture tape augmentation. *Orthop J Sports Med* 2021;9:23259671211038320.
 50. Clain JB, Vitale MA, Ahmad CS, Ruchelsman DE. Ulnar nerve complications after ulnar collateral ligament reconstruction of the elbow: A systematic review. *Am J Sports Med* 2019;47:1263-1269.
 51. Morrey BF, Sanchez-Sotelo J, Morrey ME, eds. *Morrey's the elbow and its disorders*. 5th ed. Amsterdam: Elsevier Health Sciences, 2018.
 52. Douguilh WA, Day J, Bahrn EA, Bodendorfer BM, Brandt C, Looney A. Postoperative rehabilitation of ulnar collateral ligament reconstruction: A systematic review. *Sports Med and Arthrosc Rev* 2021;29:e9-e17.
 53. Lightsey HM, Trofa DP, Sonnenfeld JJ, Swindell HW, Makhni EC, Ahmad CS. Rehabilitation variability after elbow ulnar collateral ligament reconstruction. *Orthop J Sports Med* 2019;7:2325967119833363.
 54. Kemler BR, Rao S, Willier DP, et al. Rehabilitation and return to sport criteria following ulnar collateral ligament reconstruction: A systematic review. *Am J Sports Med* 2022;50:3112-3120.

55. Conway JE. The DANE TJ procedure for elbow medial ulnar collateral ligament insufficiency. *Tech Shoulder Elbow Surg* 2006;7:36-43.
56. Keller RA, Mehran N, Marshall NE, et al. Major league pitching workload after primary ulnar collateral ligament reconstruction and risk for revision surgery. *J Shoulder Elbow Surg* 2017;26:288-294.
57. Erickson BJ, Cvetanovich GL, Bach BR, Bush-Joseph CA, Verma NN, Romeo AA. Should we limit innings pitched after ulnar collateral ligament reconstruction in major league baseball pitchers? *Am J Sports Med* 2016;44:2210-2213.
58. Camp CL, Desai V, Conte S, et al. Revision ulnar collateral ligament reconstruction in professional baseball: Current trends, surgical techniques, and outcomes. *Orthop J Sports Med* 2019;7:2325967119864104.
59. Wilson AT, Pidgeon TS, Morrell NT, DaSilva MF. Trends in revision elbow ulnar collateral ligament reconstruction in professional baseball pitchers. *J Hand Surg Am* 2015;40:2249-2254.
60. Keyt LK, Tangtiphaiboonatana J, Turner TW, Dines JS, Knudsen ML, Camp CL. Revision medial ulnar collateral ligament reconstruction in baseball pitchers: Review of epidemiology, surgical techniques, and outcomes. *Curr Rev Musculoskelet Med* 2020;13:361-368.
61. DeFroda SF, Kriz PK, Hall AM, Zurakowski D, Fadale PD. Risk stratification for ulnar collateral ligament injury in Major League Baseball players. *Orthop J Sports Med* 2016;4:2325967115627126.
62. Saper M, Shung J, Pearce S, Bompadre V, Andrews JR. Outcomes and return to sport after ulnar collateral ligament reconstruction in adolescent baseball players. *Orthop J Sports Med* 2018;6:2325967118769328.
63. Dines JS, Yocum LA, Frank JB, ElAttrache NS, Gambardella RA, Jobe FW. Revision surgery for failed elbow medial collateral ligament reconstruction. *Am J Sports Med* 2008;36:1061-1065.
64. McKnight B, Heckmann ND, Chen XT, et al. Effect of ulnar collateral ligament reconstruction on pitch accuracy, velocity, and movement in Major League Baseball pitchers. *Orthop J Sports Med* 2020;8:2325967120968530.
65. Erickson BJ, Gupta AK, Harris JD, et al. Rate of return to pitching and performance after tommy john surgery in Major League Baseball pitchers. *Am J Sports Med* 2014;42:536-543.
66. Makhni EC, Lee RW, Morrow ZS, Gualtieri AP, Gorroochurn P, Ahmad CS. Performance, return to competition, and reinjury after Tommy John surgery in Major League Baseball Pitchers: A review of 147 cases. *Am J Sports Med* 2014;42:1323-1332.
67. Jiang JJ, Leland JM. Analysis of pitching velocity in Major League Baseball players before and after ulnar collateral ligament reconstruction. *Am J Sports Med* 2014;42:880-885.