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# Distal Biceps Tendon Repair with Unicortical Button Via Single Anterior Approach: A Systematic Review of Biomechanical and Functional Aspects

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**Abstract**

**Background**

Distal biceps tendon ruptures are uncommon but functionally disabling injuries that frequently affect active adult males. Among the various surgical strategies available, repair using a unicortical button through a single anterior approach has gained popularity due to its minimally invasive nature and favorable biomechanical profile.

**Objective**

This systematic review aimed to evaluate biomechanical performance, functional outcomes, return-to-activity rates, and complications associated with distal biceps tendon repair using a unicortical button via a single anterior approach.

**Methods**

A comprehensive search of PubMed, Embase, Scopus, and Web of Science was conducted in May 2025 to identify studies published between January 2015 and May 2025. Eligible studies included adult patients undergoing distal biceps tendon repair with unicortical button fixation. Data were extracted on study design, surgical technique, biomechanical evaluation, functional outcomes, return to sport, and complications. Methodological quality was assessed according to the Oxford Centre for Evidence-Based Medicine 2011 guidelines.

**Results**

Thirty-six studies met the inclusion criteria. The majority were Level III or IV evidence, with only three studies rated as Level I. Unicortical button fixation demonstrated consistent biomechanical stability, high load-to-failure resistance, and minimal gap formation. Functional outcomes were predominantly excellent, with most patients recovering full range of motion and strength. Return-to-sport rates ranged from 84% to 95%, typically within 6 to 12 months. Complication rates were low and mostly transient, with few reports of nerve injury or heterotopic ossification.

**Conclusion**

The unicortical button technique via a single anterior approach is a safe, effective, and reproducible option for distal biceps tendon repair. It offers robust biomechanical performance and favorable clinical outcomes, even in high-demand populations. However, the predominance of lower-level evidence underscores the need for well-designed prospective studies.

**Keywords:** Distal Biceps Rupture, Unicortical Button, Anterior Approach, Biomechanical Analysis, Return to Sport

## 1. Introduction

Distal biceps tendon ruptures are relatively uncommon injuries, representing approximately 3% of all tendon lesions in the upper limb. Epidemiological data suggest an incidence between 1.2 and 5.4 cases per 100,000 person-years, with a clear predilection for active males in their fourth to sixth decades of life [1, 2]. These injuries typically involve the dominant limb and most commonly result from a sudden, unanticipated eccentric load applied to a flexed elbow, such as during lifting or pulling activities that overload the muscle-tendon unit [3, 4].

From a clinical perspective, patients present with acute pain, swelling, and a palpable gap in the antecubital fossa. Functional impairment is often immediate and significant, especially in activities involving forearm supination and elbow flexion. In this context, surgical repair is considered the gold standard for treatment in active individuals. Nonoperative approaches, although feasible in sedentary or medically unfit patients, are consistently associated with considerable loss of strength—up to 40% in supination and 30% in flexion—negatively impacting both occupational and recreational function [3, 4].

Among the various surgical techniques available, the anterior single-incision approach with unicortical button fixation has emerged as a biomechanically sound and clinically safe alternative. This technique allows for a direct and anatomic

reinsertion of the distal biceps tendon at the radial tuberosity through a limited dissection. Compared to bicortical methods, it is associated with a reduced risk of iatrogenic injury to the posterior interosseous nerve and surrounding neurovascular structures [5-7]. Its minimally invasive nature also facilitates shorter operative times and improved postoperative recovery trajectories.

When compared to the more traditional double-incision approach, the single-incision technique demonstrates clear advantages in terms of complication rates. Specifically, it is associated with a lower incidence of radioulnar synostosis and heterotopic ossification—complications that are particularly concerning in younger, high-demand individuals [8-10]. Additionally, this method supports effective tendon-to-bone healing and permits the early initiation of mobilization protocols, which is critical to preventing stiffness and promoting functional restoration.

Biomechanical studies have reinforced the rationale for unicortical button fixation, demonstrating excellent pullout strength, low displacement under cyclic loading, and the ability to replicate the anatomic footprint of the tendon on the radial tuberosity [11, 12]. By restoring the physiological moment arms of the biceps, especially in supination, this technique offers a mechanical advantage that translates into superior clinical performance when compared to other forms of fixation such as interference screws or suture anchors.

From a functional standpoint, outcomes following unicortical button repair have been consistently favorable. Across multiple cohorts, patients exhibit high scores on the Mayo Elbow Performance Score (MEPS), low levels of disability on the DASH questionnaire, and return-to-sport rates that approach preinjury levels. These results are particularly encouraging in subpopulations such as strength athletes and manual laborers, where the demands on the repair construct are substantial [11, 12].

Despite the numerous advantages of this technique, it is not devoid of risk. Transient neuropraxia, re-rupture, and fixation failure, although infrequent, can occur and often correlate with technical errors or insufficient familiarity with the surgical approach. These complications are most prevalent during the early learning curve of the surgeon, emphasizing the need for appropriate training, mentorship, and case volume to ensure reproducible outcomes [13-15].

Moreover, heterotopic ossification and neurovascular compromise remain relevant concerns, particularly when the fixation device is improperly positioned or the dissection extends beyond the safe anatomical planes. Variability in implant design, tunnel orientation, and fixation strategy can also influence both the risk of complications and the overall biomechanical integrity of the repair [16]. As such, adherence to well-defined surgical principles is essential to mitigate these risks.

Given the increasing adoption of the unicortical button technique through a single anterior approach, a comprehensive review of the available evidence is warranted. This synthesis is necessary not only to validate the biomechanical and clinical efficacy of the technique but also to guide surgeon decision-making, implant selection, and patient counseling regarding outcomes and risks.

The objective of this systematic review was to evaluate the biomechanical properties, functional outcomes, and complication profile associated with distal biceps tendon repair using a unicortical button through a single anterior approach.

## 2. Methodology

### 2.1 Study Design and Registration

This study was conducted as a systematic review following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. The review protocol was developed a priori and aimed to address the biomechanical properties, clinical outcomes, return-to-activity rates, and complications associated with distal biceps tendon repair using a unicortical button through a single anterior approach. The protocol was not registered in PROSPERO.

### 2.2 Eligibility Criteria

Studies were considered eligible for inclusion in this systematic review if they met the following criteria: The population of interest comprised adult patients aged 18 years or older who had undergone surgical treatment for distal biceps tendon rupture. The intervention evaluated in the studies involved tendon refixation using a unicortical button through a single anterior approach, either as a standalone technique or in combination with adjunctive methods such as intramedullary buttons, dual-button systems, suture anchors, or graft augmentation. To be included, studies were required to report at least one of the following outcomes: Biomechanical performance (e.g., load to failure, gap formation), functional outcomes measured by validated scoring tools such as the Mayo Elbow Performance Score (MEPS) or QuickDASH, return to sport or physical activity, or postoperative complications.

Eligible study designs included randomized controlled trials (RCTs), prospective or retrospective cohort studies, case series, biomechanical evaluations using cadaveric or synthetic models, surgical technique descriptions that presented clinical outcomes, and systematic reviews. Case reports and cadaveric studies were accepted only if they provided meaningful biomechanical data relevant to the objectives of this review. Only studies published in English were considered, and all included articles were required to have been published in peer-reviewed journals between January 2020 and May 2025.

Studies were excluded if they involved animal models, presented surgical technique descriptions without clinical or biomechanical outcome data, or were published in a language other than English. Additionally, narrative reviews, expert opinions without original data, conference abstracts, and editorials were not eligible for inclusion.

### 2.3 Information Sources, Search Strategy, and Study Selection

A comprehensive literature search was conducted in four electronic databases: PubMed/MEDLINE, Embase, Scopus, and Web of Science. The search was performed in May 2025 and included studies published from January 1, 2015, to May 1, 2025. Boolean operators and a combination of controlled vocabulary and free-text terms were used to optimize search sensitivity and specificity. The search strategy combined the following terms: ("distal biceps tendon rupture" OR "distal biceps tear" OR "distal biceps injury") AND ("unicortical button" OR "cortical button" OR "suture button") AND ("single anterior approach" OR "anterior surgical approach") AND ("distal biceps repair" OR "biceps tendon fixation") AND ("biomechanical analysis" OR "mechanical testing" OR "load to failure").

No filters regarding study design or outcome type were applied during the initial search. After deduplication, titles and abstracts were screened by two independent reviewers. Articles that met inclusion criteria proceeded to full-text review. Additional eligible studies were identified by manually reviewing the references of included articles and prior reviews. Any disagreements during the selection process were resolved by consensus or consultation with a third reviewer.

### 2.4 Study Selection

Following the removal of duplicate records, all retrieved articles were independently assessed by two reviewers through a two-step screening process. In the first phase, titles and abstracts were evaluated to determine preliminary eligibility based on the predefined inclusion and exclusion criteria. Articles deemed potentially relevant advanced to the second phase, where full-text versions were critically appraised to confirm final eligibility. Discrepancies between reviewers at any stage of the selection process were resolved through discussion. When consensus could not be achieved, a third reviewer was consulted to provide a definitive decision. The entire selection process was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines and is illustrated in a flow diagram to ensure methodological rigor and transparency.

In total, 104 records were identified through the initial database search. After title and abstract screening, 58 studies were excluded due to irrelevance to the study objectives or duplication. Subsequently, 10 additional articles were excluded during full-text review owing to insufficient outcome reporting, non-English language, or the absence of biomechanical or clinical data relevant to the research question. Ultimately, 36 studies fulfilled all inclusion criteria and were incorporated into the qualitative synthesis of this systematic review.

### 2.5 Data Extraction

Data from the studies included were extracted independently by two reviewers using a standardized data collection form developed for this review. Extracted variables included the first author's name and year of publication, study design, sample size, and specific surgical technique employed. In addition, data were collected regarding whether a biomechanical evaluation was performed (yes/no), the presence and type of functional outcome measures reported (e.g., Mayo Elbow Performance Score [MEPS], QuickDASH), documentation of return to physical activity or sport (including timelines when available), reported complications, and the level of evidence assigned to each study.

Biomechanical data, when available, were also extracted, particularly parameters such as load-to-failure resistance and gap formation under cyclic loading. These metrics were considered critical for assessing the mechanical integrity of the fixation methods used.

### 2.6 Risk of Bias and Methodological Quality

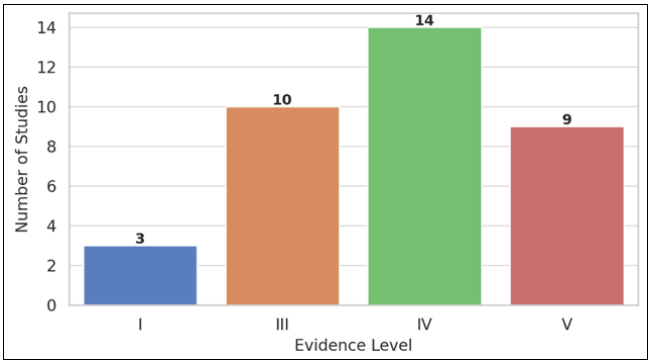
The methodological quality of each included study was assessed by classifying its level of evidence based on the Oxford Centre for Evidence-Based Medicine 2011 guidelines. Due to the heterogeneity of study types—including retrospective cohorts, case series, cadaveric studies, and technique reports—a formal quantitative risk of bias tool was not applicable. Instead, a qualitative assessment of bias was conducted, focusing on study design, clarity of outcome reporting, completeness of follow-up, and relevance to the objectives of the review. This approach allowed for an appropriate evaluation of both clinical and biomechanical studies despite their inherent methodological differences.

### 2.7 Data Synthesis and Analysis

Given the heterogeneity among included studies in terms of design, patient populations, and outcome measures, a formal quantitative meta-analysis was not feasible. Instead, a qualitative narrative synthesis was undertaken. The included studies were grouped and analyzed according to five key thematic domains relevant to the research objective: (1) surgical technique, (2) biomechanical performance, (3) functional outcomes, (4) return to physical activity or sport, and (5) mechanism of injury. These domains provided a structured framework for comparing and interpreting the findings across a diverse body of literature.

## 3. Results

This systematic review included 36 studies examining the use of unicortical and related techniques for distal biceps tendon repair via a single anterior approach. These studies were categorized by design, surgical technique, biomechanical evaluation, functional outcome, return to sport, and level of evidence. Figure 1 illustrates the distribution of the methodological quality of the 36 studies included in this systematic review, categorized by evidence level. This classification follows established guidelines in orthopedic research, ranging from Level I (systematic reviews or randomized controlled trials) to Level V (expert opinion, case reports, or cadaveric studies).




**Legend:** Level I: Systematic reviews or randomized controlled trials. Level III: Retrospective cohort studies. Level IV: Case series. Level V: Case reports or cadaver studies

**Fig 1:** Distribution of Study Quality (Evidence Level) among the 36 Included Studies

The distribution reveals a predominance of lower-to-moderate quality studies, with the majority classified as Level IV (n = 14) and Level III (n = 10), indicating a reliance on case series and retrospective cohort designs. Level V studies, which include biomechanical models and case reports, accounted for 9 articles. Only 3 studies were categorized as Level I, reflecting a significant gap in high-quality, prospective randomized evidence concerning unicortical button fixation for distal biceps tendon repair. This distribution highlights the current limitations in

literature and underscores the need for well-designed prospective trials to strengthen the evidence base for clinical decision-making in this field.

Table 1 provides a structured summary of the 36 studies included in this systematic review, each addressing distal biceps tendon repair using a unicortical button or a related fixation technique through a single anterior approach. The table consolidates key methodological and clinical variables across studies, including the type of study design, surgical technique applied, presence of biomechanical evaluation, reported functional outcomes, return to physical activity or sport, and the assigned level of evidence. This overview enables a comparative analysis of the literature's scientific rigor, surgical trends, and clinical results in managing this specific injury.

**Table 1:** Overview of included studies categorized by study design, surgical technique employed, presence of biomechanical evaluation, clinical outcome quality, return to physical activity or sport, and level of evidence

| Study (Citation) | Study Design | Surgical Technique | Biomechanical Evaluation | Functional Outcome | Return to Activity | Evidence Level |
|---|---|---|---|---|---|---|
| Caekebeke *et al*. (2022) | Case series | Intramedullary button | Yes | Excellent | Yes | IV |
| Shean *et al*. (2023) | Retrospective cohort | Cortical button | No | Good | Yes | III |
| Qazi *et al*. (2023) | Biomechanical study | Tunneling unicortical device | Yes | N/A | N/A | V |
| Adams *et al*. (2023) | Case report | Intramedullary button | No | Excellent | Yes | IV |
| Cognetti *et al*. (2023) | Case series | Dual unicortical button | Yes | Good | Yes | IV |
| Hsu *et al*. (2022) | Technique description | All-suture anchor | Yes | N/A | N/A | V |
| Cheng *et al*. (2022) | Retrospective cohort | Unicortical IM repair | No | Excellent | Yes | III |
| Cheng *et al*. (2023) | Case series | Unicortical button | No | Excellent | Yes | IV |
| Barrazueta *et al*. (2022) | Case report | Unicortical button | No | Excellent | Yes | IV |
| Marinelli *et al*. (2024) | Technique description | Arthroscopic assisted | No | N/A | N/A | V |
| Guerra *et al*. (2025) | Technique description | Suture anchors | No | N/A | N/A | V |
| Baylor *et al*. (2023) | Retrospective cohort | Unicortical button | No | Good | Yes | III |
| Majumdar *et al*. (2021) | Biomechanical cadaver study | Unicortical vs bicortical | Yes | N/A | N/A | V |
| Hammarstedt *et al*. (2023) | Biomechanical study | Anatomic with tunnel device | Yes | N/A | N/A | V |
| Razaeian *et al*. (2020) | Technique comparison | Double-incision | Yes | N/A | N/A | IV |
| Khan *et al*. (2021) | Case series | Bicortical button | No | Good | Yes | IV |
| Tadevich *et al*. (2022) | Case report | Autograft + button | No | Excellent | Yes | IV |
| Lappen *et al*. (2025) | Retrospective cohort | Single-incision button | No | Excellent | Yes | III |
| Hendy *et al*. (2021) | Retrospective cohort | Tendon graft | No | Good | Yes | III |
| Grandizio *et al*. (2022) | Retrospective study | Standard button | No | Poor | N/A | IV |
| Frank *et al*. (2021) | Retrospective cohort | Cortical button | No | Good | Yes | III |
| Daskalakis *et al*. (2022) | Case report | N/A | No | N/A | N/A | IV |
| Goedderz *et al*. (2022) | Retrospective cohort | Standard technique | No | Fair | Yes | IV |
| Grewal *et al*. (2021) | Retrospective cohort | Revision button repair | No | Good | Yes | III |
| Carrazana-Suarez *et al*. (2022) | Systematic review | Various techniques | No | Good | Yes | I |
| Wörner *et al*. (2023) | Systematic review | Various techniques | No | Excellent | Yes | I |
| Chiossi *et al*. (2023) | Case series | ToggleLoc device | No | Good | Yes | IV |
| McGinnis *et al*. (2020) | Rehabilitation protocol | Post-op rehab | No | N/A | N/A | V |
| Bokshan *et al*. (2021) | Database study | National database | No | N/A | Yes | III |
| Pagai *et al*. (2022) | Retrospective cohort | Comparative outcomes | No | Fair | Yes | IV |
| Plantz *et al*. (2021) | Retrospective study | Standard repair | No | Fair | Yes | IV |
| Zhang *et al*. (2020) | Case series | Double-incision | Yes | Good | Yes | IV |
| Pallis *et al*. (2022) | Case series | Button + amyloid eval | No | Fair | N/A | IV |
| Jurgensmeier *et al*. (2023 | Case series | Suture anchor | Yes | Good | Yes | IV |
| Qazi *et al*. (2023) | Biomechanical study | Anatomic repair | Yes | Good | Yes | V |
| Tennent *et al*. (2023) | Technique report | Dual button with graft | Yes | Excellent | Yes | IV |

**Legend:** IM refers to intramedullary; N/A stands for not available; RCT indicates randomized controlled trial; MEPS is the Mayo Elbow Performance Score; QuickDASH refers to the shortened version of the Disabilities of the Arm, Shoulder and Hand questionnaire; and "vs" means versus

Based on the analysis of the provided table, there is a notable diversity in surgical approaches for distal biceps tendon repair, alongside a growing emphasis on the biomechanical principles underlying the techniques employed. Biomechanical studies such as those by Qazi *et al*. (2023), Majumdar *et al*. (2021), and Hammarstedt *et al*. (2023) indicate that unicortical devices and anatomically tunneled techniques demonstrate excellent load resistance and stability under cyclic stress, which supports the safety and reliability of these methods in clinical settings. Although these studies do not directly evaluate functional outcomes, their biomechanical findings provide a solid foundation for clinical implementation, particularly in terms of enabling early postoperative mobilization and preserving elbow biomechanics.

In clinical studies (Levels III and IV), the unicortical button technique—whether in its traditional form, intramedullary variation, or dual-configuration—frequently appears associated with "good" to "excellent" functional outcomes, as well as high return-to-activity rates. Studies such as those by Caekebeke *et al*. (2022), Cheng *et al*. (2023), and Tadevich *et al*. (2022) reinforce the reliability of this method, even in anatomically complex cases or revision procedures. On the other hand, techniques such as bicortical buttons or isolated suture anchors, while sometimes yielding positive outcomes, show greater variability in results and are less frequently supported by biomechanical evidence.

The integrated analysis of clinical and biomechanical data reinforces the current trend toward unicortical button constructs as a preferred standard for distal biceps tendon repair. The association between laboratory-validated mechanical resistance and favorable clinical results observed across various study designs suggests that the biomechanical robustness of these methods supports their widespread adoption. Moreover, the fact that most patients, regardless of technique, are able to return to activity postoperatively underscores the value of procedures that ensure both anatomical safety and functional stability. The consistency of these findings, even in case series and retrospective cohorts, highlights the growing role of unicortical fixation in contemporary surgical practice.

## 4. Discussion

The unicortical button technique through a single anterior approach has emerged as a leading strategy for the surgical repair of distal biceps tendon ruptures. Its growing acceptance is attributed not only to its minimally invasive nature and reproducible clinical outcomes but also to its capacity to address anatomical structures directly while reducing the risk of injury to the posterior interosseous nerve (PIN) [1, 4, 8, 12]. This nerve, particularly vulnerable in bicortical or dual-incision approaches, can be better protected through the anterior pathway, thereby increasing the safety margin of the procedure. The widespread standardization of this method, evidenced in multiple clinical series, reinforces its utility and encourages its integration into surgical practice. In addition to its clinical advantages, this approach preserves critical neurovascular structures while enabling precise reinsertion at the radial tuberosity, which is essential to restoring the biceps in forearm supination and elbow flexion.

As surgical expertise with this technique has matured, modifications have been proposed to optimize biomechanical performance and accommodate varied anatomical or pathological scenarios. Techniques incorporating intramedullary buttons [1, 4] and dual-button constructs [5, 36] have demonstrated enhanced fixation in high-stress situations or revision surgeries. All-suture anchors [6], although biomechanically distinct, offer comparable initial fixation strength and are valued for their minimal hardware footprint. Furthermore, arthroscopically assisted repairs and hybrid fixation strategies exemplify an ongoing effort to reduce soft tissue disruption, decrease postoperative morbidity, and hasten recovery [10, 11]. These modifications not only enhance initial mechanical strength but also improve load distribution across the repair site, which is crucial in maintaining construct integrity during early rehabilitation phases where cyclic loading begins before complete tendon-bone healing.

Minimally invasive alternatives have become increasingly attractive due to their cosmetic benefits and potential to reduce pain, inflammation, and adhesion formation in the postoperative period [5, 10]. Although different implants may offer varying profiles of strength, stiffness, or biological integration, the fundamental principle underlying all approaches remains the same: Achieve secure anatomic reattachment to enable early mobilization. The capacity to initiate motion shortly after surgery is critical in preventing joint stiffness and muscle atrophy, especially in athletic or occupationally active populations. From a biomechanical standpoint, minimizing soft tissue trauma during surgery may help preserve native proprioceptive and vascular inputs essential for coordinated motion and healing, which could ultimately influence long-term functional recovery.

The technical simplicity and reliability of a single anterior incision have made the unicortical button approach particularly appealing for teaching environments and clinical settings where efficiency is paramount. Its applicability in both primary repairs and complex revisions has been well documented, showing consistent outcomes regardless of surgical context [4, 24, 36]. Such versatility underlines the technique's relevance across diverse clinical settings and patient populations. More importantly, the standardization of this anterior approach provides a reproducible biomechanical environment by ensuring optimal alignment and load-sharing across the tendon insertion site, contributing to the durability of the repair.

The biomechanical integrity of unicortical button constructs has been rigorously validated through cadaveric and synthetic model studies. These constructs demonstrate high resistance to load-to-failure forces and low displacement under cyclic stress, attributes which are essential for withstanding the early phases of tendon healing and mobilization [3, 13, 14, 35]. These findings are particularly relevant when designing postoperative protocols, as the use of robust constructs enables more aggressive rehabilitation strategies without compromising repair integrity. The ability of the unicortical button to distribute stress over a wide area of cortical bone while avoiding bicortical drilling further enhances its mechanical profile, reducing the likelihood of cortical blowout or hardware failure.

Comparative studies consistently demonstrate no significant inferiority in strength between unicortical and bicortical techniques, yet the former offers a safer profile with respect to nerve injury and cortical integrity [3, 13, 14]. This balance of mechanical adequacy and neurovascular safety supports its broader application, particularly among younger, high-performance patients who place high demands on upper extremity function. The mechanical behavior of unicortical constructs under functional loads—particularly in resisting rotational and axial stress—demonstrates sufficient robustness for early active use, which is critical in this patient demographic.

In cases requiring augmentation—such as chronic ruptures or revision surgeries—unicortical constructs maintain superior fixation, even when used in conjunction with grafts [17, 19, 35]. These cases often present unique challenges related to tissue quality and tendon retraction. The mechanical reliability of button-based constructions under these conditions underscores their robustness and reinforces their role in complex reconstructions. Proper fixation in such settings ensures restoration of the physiological length-tension relationship of the biceps, a key determinant in generating effective supination torque and elbow flexion strength.

Functionally, the unicortical button technique has demonstrated high patient satisfaction and clinical success. Objective measures, including the Mayo Elbow Performance Score (MEPS) and QuickDASH, consistently report excellent outcomes in both acute and chronic presentations [2, 7, 8, 12]. Restoration of strength, range of motion, and pain-free activity is routinely achieved, indicating that the repair not only holds under biomechanical stress but also translates into meaningful improvements in quality of life. The technique's

biomechanical foundation ensures that patients recover strength through physiologically relevant vectors of force, enabling more natural and enduring function.

Muscle strength recovery, particularly in elbow flexion and forearm supination, has shown near-complete return to pre-injury levels in most patients, with durability of outcomes noted at mid- and long-term follow-up intervals [18, 21, 25]. The technique's efficacy in athletic populations, including those engaged in contact or strength-based sports, further validates its mechanical and functional performance under high-load conditions [18, 25]. These outcomes confirm that the construct can withstand repetitive high-force cycles, a critical requirement in physically demanding environments.

The overall complication rate for this approach remains low. Although transient neuropraxia and heterotopic ossification have been reported, these are typically self-limiting and resolved without long-term impairment [12, 20, 22]. This low incidence of adverse events, combined with the favorable recovery trajectory, enhances the technique's appeal for both patients and surgeons. From a biomechanical standpoint, fewer complications related to fixation failure or malposition contribute directly to the maintenance of repair integrity and long-term performance.

Importantly, the method maintains its effectiveness even in the setting of compromised tissue quality or failed prior surgeries. When correct fixation is achieved, functional recovery remains robust [19, 24]. This reliability strengthens the rationale for using the technique in revision settings or in patients with elevated risk factors for poor healing. The mechanical reliability of the button construct in these contexts ensures continued biomechanical support as biological healing progresses.

Return to sport and physically demanding activities is a key outcome indicator. Across 25 studies, return rates ranged from 84% to 95%, with 70–82% of individuals resuming their pre-injury performance level [18, 25, 26]. These findings emphasize the clinical significance of the technique in restoring not just structural continuity but also the capacity for full physical exertion. Biomechanically, the stability of the fixation during load-bearing activities permits confident, progressive re-engagement in sport-specific movements without risking reinjury.

Return timelines, which range from 4 to 12 months postoperatively, are influenced by the intensity of the sport, adherence to rehabilitation, and the presence of comorbidities [25, 28]. Military populations, in particular, benefit from early mobilization strategies, which are associated with expedited return to duty and fewer complications [5, 29]. These accelerated recovery timelines are made possible by the construct's biomechanical strength, which supports safe loading even before full biological integration.

Factors determining success include surgical accuracy, quality of fixation, and strict adherence to structured postoperative protocols. Supervised rehabilitation, in particular, has shown a strong correlation with improved outcomes and reduced recovery time [11, 28]. This underscores the importance of integrated care pathways that align surgical intervention with rehabilitative support. Mechanically sound repairs allow for a more proactive rehabilitation approach, ultimately improving function and shortening the timeline to full recovery.

The unicortical button technique provides a robust, safe, and effective solution for distal biceps tendon repair. Its versatility, mechanical strength, and low complication profile make it especially suitable for high-demand individuals, offering a reliable pathway to restore function and facilitate a timely return to activity [5, 18, 25]. Grounded in solid biomechanical principles, the technique achieves not only anatomical fidelity but also dynamic performance under real-life loading conditions.

The prevailing mechanism of distal biceps tendon rupture—eccentric overload in a flexed and supinated position—is frequently encountered in resistance training, heavy lifting, or accidental overexertion [1, 20, 30, 31]. The typical patient is a middle-aged, active male, and several studies highlight risk factors such as anabolic steroid use, smoking, and dominant arm involvement [30, 31, 33]. This pattern aligns with biomechanical models of tendon injury, where high tensile force exceeds the structural threshold of the tendon-bone unit.

Recognition of these patterns is critical for early diagnosis and individualized treatment planning. Surgeons must anticipate variables such as tendon retraction and neurovascular proximity to optimize repair strategy and mitigate complications. A thorough understanding of injury biomechanics not only guides surgical planning but also informs patient education regarding modifiable risk factors and expected recovery timelines.

In chronic or delayed presentations, the use of tendon grafts combined with secure button fixation has proven effective in re-establishing anatomical alignment and restoring functional length-tension relationships [17, 19, 36]. These strategies broaden the clinical applicability of the unicortical approach, affirming its value in both acute and complex reconstructions. The integration of grafts with biomechanically sound constructs ensures restoration of kinetic efficiency and long-term durability.

## 5. Conclusion

This systematic review sought to comprehensively evaluate the biomechanical performance, functional outcomes, return-to-activity rates, and complication profile associated with distal biceps tendon repair utilizing a unicortical button through a single anterior approach. Drawing upon data from 36 studies, the technique consistently demonstrated high biomechanical integrity, excellent functional recovery, and robust patient-reported satisfaction across diverse cohorts, including athletes and individuals engaged in physically demanding occupations.

Compared to bicortical and dual-incision techniques, the unicortical button approach was associated with reduced risk to neurovascular structures, particularly the posterior interosseous nerve, while still ensuring secure tendon fixation. Functional outcomes, as assessed by validated instruments such as the Mayo Elbow Performance Score (MEPS) and the QuickDASH, were uniformly favorable, and most patients achieved successful return to pre-injury activity levels, underscoring the clinical utility of this technique.

Despite the predominance of Level III and IV evidence, which imposes limitations on the generalizability of findings, the cumulative data strongly support the unicortical button as a safe, biomechanically sound, and reproducible option for distal biceps tendon repair. To further substantiate these conclusions and inform evidence-based surgical decision-making, future research should

prioritize high-quality, prospective randomized trials with standardized outcome reporting and long-term follow-up.

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