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CONTEMPORARY PERSPECTIVES ON THE MANAGEMENT OF DISTAL BICEPS TENDON RUPTURE

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Summary. *This article reviews the contemporary approaches to managing distal biceps tendon rupture (DBTR), comparing conservative and surgical treatments. The findings are based on a systematic analysis of recent studies, emphasizing the superior functional outcomes of surgical interventions, particularly in younger and physically active patients. Conservative treatment is discussed as a viable option for older individuals or those with comorbidities, highlighting its limitations in strength and endurance recovery. The article also explores various surgical techniques, including single-incision, two-incision, and arthroscopic approaches, alongside fixation methods such as cortical buttons and suture anchors. Emerging trends in fixation techniques are presented, underscoring the potential of adaptive loop cortical buttons. The study concludes that while surgical treatment remains the preferred method for most patients, individualized approaches considering patient-specific factors ensure optimal outcomes.*

Key words*: biceps brachii muscle; tendon injuries; conservative treatment; surgical treatment; tendon refixation; biceps tendon.*

SECTION XXX. MEDICAL SCIENCES AND PUBLIC HEALTH

Introduction. The management of distal biceps tendon rupture (DBTR) involves two primary strategies: conservative and surgical treatment. While the debate on their comparative efficacy dates back to the 20th century, advancements in research methodologies and clinical trials have provided new insights into their outcomes [1]. This review synthesizes recent findings to evaluate contemporary treatment strategies for DBTR.

Conservative Treatment.

Conservative management of distal biceps tendon ruptures primarily involves a non-surgical approach focused on alleviating symptoms and gradually restoring function. This treatment typically includes rest to allow the injured tendon to stabilize, the use of non-steroidal anti-inflammatory drugs (NSAIDs) to reduce pain and inflammation, and a structured physical therapy program tailored to the patient's specific needs [2].

Physical therapy plays a central role in conservative treatment, aiming to strengthen the surrounding musculature, improve joint mobility, and compensate for any loss of tendon functionality. Exercises are progressively introduced to restore wrist and elbow strength, particularly focusing on supination and flexion movements [3]. The therapy program is often designed to minimize strain on the affected tendon while maximizing functional recovery over time.

This approach is best suited for patients with lower functional demands or those for whom surgical intervention poses significant risks. For example, individuals with advanced age, chronic illnesses, or comorbid conditions such as diabetes, cardiovascular disease, or coagulopathies may benefit from the non-invasive nature of conservative management. Additionally, sedentary individuals or those with limited physical activity requirements may find the outcomes of conservative treatment satisfactory, even with some degree of residual strength loss.

However, conservative management is associated with certain limitations. Patients may experience a permanent reduction in supination and flexion strength, as well as endurance deficits, which may impact daily activities. While this approach avoids surgical risks and recovery challenges, it may not fully restore the tendon's pre-injury strength or function. Consequently, conservative management should be carefully considered based on the patient's medical history, lifestyle, and treatment goals, ensuring that expectations align with the likely outcomes of non-surgical care.

Strength and Endurance Deficits:

- Supination strength may decrease by 21%-55%.
- Supination endurance can decline by 79%.
- Flexion strength reductions range from 10%-40% [4].

Despite these limitations, studies have shown that conservative management can yield satisfactory outcomes in select patient populations. For example, Berthold et al. [2] noted that older, sedentary individuals often achieve acceptable levels of functionality despite reduced strength metrics.

Surgical Treatment. Surgical repair is widely regarded as the gold standard for DBTR, particularly for younger patients or those with high physical demands. Numerous studies have highlighted its superior outcomes compared to conservative management:

- Functional Improvements:
  - Flexion strength: +25.67% ($P < .0001$).
  - Supination strength: +27.56% ($P < .0001$).
  - Endurance improvements in both flexion and supination [5].
- Patient-Reported Outcomes (PROs):
  - DASH scores improved significantly (-7.81, $P < .0001$).
  - MEPS scores showed notable advantages (+7.41, $P = .0224$) [6].

Comparative Studies: Cuzzolin et al. [4] emphasized that surgical repair consistently outperformed conservative treatment in terms of strength recovery, PROs, and overall satisfaction. Similarly, Jaschke et al. [3] underscored the benefits of anatomical reinsertion, which offers high levels of patient satisfaction and functional restoration.

However, surgical intervention is not without risks. Complications such as nerve damage, heterotopic ossification, and cosmetic concerns require thorough preoperative counseling [7].

Surgical Techniques

1. Single-Incision Technique: This approach involves an incision in the antecubital fossa, which provides direct access to the ruptured distal biceps tendon. The technique is often favored for its simplicity and cosmetic advantages, as it requires only a single surgical incision, resulting in reduced scarring compared to the two-incision technique. During the procedure, the surgeon identifies the tendon stump, prepares the radial tuberosity for reattachment, and performs fixation using methods such as suture anchors, interference screws, or cortical button devices. However, the single-incision technique carries notable risks, particularly related to neurovascular complications [8]. These include potential injury to the lateral antebrachial cutaneous nerve and the posterior interosseous nerve, as the proximity of these structures to the surgical site increases the likelihood of entrapment or damage during the procedure. Additionally, excessive retraction during the surgery may lead to soft tissue ischemia or other vascular issues. Despite these risks, the single-incision technique remains widely used due to its shorter operative time, better aesthetic outcomes, and minimal postoperative pain compared to alternative methods. However, surgeons must exercise caution during tendon mobilization and fixation to mitigate neurovascular risks. Preoperative imaging and intraoperative visualization techniques, such as fluoroscopy or nerve monitoring, are often employed to enhance the safety and efficacy of the procedure.

2. Two-Incision Technique: Boyd-Anderson's method utilizes anterior and posterior incisions, which enhance surgical visualization and provide direct access to both the distal biceps tendon stump and the radial tuberosity. This dual-incision technique is designed to minimize the risk of nerve injury, particularly to the posterior interosseous nerve. The anterior incision allows for the identification and preparation of the ruptured tendon, while the posterior incision facilitates allows for fixation with less risk of damage to the posterior interosseous nerve. The procedure commonly involves fixation methods such as cortical buttons, suture anchors, or transosseous sutures, which can be employed with high accuracy due to the enhanced visualization afforded by the posterior approach. Despite these benefits, the Boyd-Anderson method carries its own set of challenges and potential complications. The use of two incisions may lead to increased soft-tissue trauma, a higher risk of wound complications, and prolonged recovery times. Additionally, the posterior incision poses a risk of damage to the posterior soft tissues and may result in scarring or postoperative stiffness in the elbow. Careful dissection and handling of tissues are essential to minimize these risks. The Boyd-Anderson method is often preferred in cases of chronic ruptures, where visualization of the radial tuberosity is crucial for effective fixation. It is also a suitable choice for patients with high functional demands, as the technique is associated with improved tendon positioning and restoration of anatomical integrity. However, the choice of this approach should be based on the individual patient's anatomy, the extent of tendon retraction, and the surgeon's expertise, as the added complexity of the procedure requires advanced surgical skills and thorough knowledge of elbow anatomy. [9].

3. Arthroscopic Techniques: Arthroscopic-assisted repairs are a modern, minimally invasive approach to treating distal biceps tendon ruptures, offering the advantages of superior visualization and reduced tissue trauma [10]. This technique

involves the use of an arthroscope, typically inserted through small incisions around the elbow joint, to allow precise identification and handling of the ruptured tendon and its reattachment site. The procedure minimizes the disruption of surrounding soft tissues, which is particularly beneficial in cases of acute ruptures or patients with higher cosmetic concerns. The arthroscopic method begins with the introduction of the arthroscope into the elbow joint to locate the tendon stump. Specialized tools, such as shavers and radiofrequency devices, are used to debride the radial tuberosity, preparing it for tendon fixation. Fixation is most commonly achieved using suture anchors or cortical buttons, which can be placed with high accuracy under arthroscopic guidance. The technique also allows for thorough inspection and treatment of concurrent intra-articular pathologies, such as synovitis or cartilage damage, which may not be addressed with traditional open methods. Studies by Reichert et al. [5] and Bhatia et al. [7] have demonstrated that arthroscopic repairs result in favorable functional outcomes, including improved range of motion, reduced postoperative pain, and faster recovery compared to traditional open techniques. These benefits are attributed to the minimally invasive nature of the procedure, which limits soft-tissue damage and decreases the likelihood of complications such as scarring and stiffness. Despite these advantages, the arthroscopic technique requires a high degree of surgical expertise and specialized equipment. Surgeons must be proficient in arthroscopic navigation and manipulation, as the confined space and proximity of neurovascular structures in the elbow increase the complexity of the procedure. Additionally, the setup for arthroscopic surgery is resource-intensive, often involving advanced optical systems, arthroscopic tools, and fixation devices, which may not be readily available in all surgical centers. Arthroscopic-assisted repair is particularly well-suited for patients with acute ruptures or those who prioritize minimal scarring and faster recovery. However, its application in chronic ruptures may be limited due to significant tendon retraction or scarring, which may necessitate conversion to an open approach. As the technique continues to evolve, further research and clinical trials are needed to standardize the procedure, improve its accessibility, and establish long-term outcomes for various patient populations.

Fixation Methods:

- Suture Anchors: Suture anchors are a commonly used method for tendon fixation in distal biceps repair. These devices are embedded into the radial tuberosity, allowing the ruptured tendon to be securely reattached through sutures passed through the anchor's eyelets. While suture anchors are effective in achieving initial fixation, studies have shown that they may be prone to loosening under repetitive mechanical stress [5]. This can result in reduced long-term stability and a higher risk of fixation failure, particularly in patients with high physical demands. Nonetheless, suture anchors remain a popular choice due to their straightforward application and availability in surgical practice.
- Interference Screws: Interference screws are another widely used fixation method, often employed to augment primary fixation techniques. These screws are placed within a pre-drilled tunnel in the radial tuberosity, compressing the tendon against the bony surface to create a strong interface. While interference screws provide good biomechanical strength, they are rarely used as a standalone fixation

method. Instead, they are commonly combined with other techniques, such as cortical buttons or suture anchors, to enhance fixation stability. The primary limitation of interference screws is their reliance on precise tunnel placement and the risk of damaging adjacent structures if misaligned.

- Cortical Button Fixation: Cortical button fixation is increasingly regarded as the gold standard for distal biceps tendon repair due to its superior biomechanical strength and ability to withstand cyclic loading. This method involves passing the tendon through a cortical button, which is then secured on the opposite side of the radial cortex. The technique enables a stable fixation that resists displacement, facilitating early mobilization and reducing the risk of stiffness. Additionally, cortical buttons are associated with fewer complications compared to suture anchors or interference screws, making them a preferred choice in both acute and chronic cases. However, precise placement of the cortical button is critical to avoid neurovascular complications. [5].
- Hybrid Techniques: Hybrid fixation methods combine the advantages of different techniques, such as using cortical buttons in conjunction with interference screws. These approaches aim to enhance stability and ensure secure tendon fixation. Despite theoretical benefits, studies have not demonstrated significant clinical advantages of hybrid techniques over standalone cortical button fixation. The additional complexity and cost associated with hybrid methods further limit their widespread adoption. Current evidence suggests that cortical button fixation alone provides sufficient biomechanical strength and excellent clinical outcomes, minimizing the need for hybrid strategies. [10].

Each fixation method has its unique strengths and limitations, and the choice often depends on the patient's anatomy, the extent of the rupture, and the surgeon's expertise. Ongoing research continues to refine these techniques, with the goal of improving outcomes and reducing complications in distal biceps tendon repair.

Emerging Techniques and Challenges. The adoption of adaptive loop cortical buttons represents a promising innovation in the fixation of distal biceps tendon ruptures. This advanced technique combines the biomechanical stability of traditional cortical buttons with the added advantage of adjustable loop lengths, enabling precise anatomical fixation. By allowing the loop length to be tailored during surgery, adaptive loop cortical buttons ensure optimal tendon-to-bone contact, potentially improving healing outcomes and reducing the risk of retraction or gapping at the repair site.

Biomechanical studies suggest that adaptive loop systems provide excellent strength under cyclic loading, comparable to or exceeding that of fixed cortical button systems. Additionally, the adjustable loop can accommodate variations in tendon length, making this technique particularly useful in cases of chronic ruptures where significant retraction has occurred. The ability to achieve tension-free fixation is a key advantage, as it minimizes strain on the repair construct and promotes biological healing.

Despite these potential benefits, the clinical application of adaptive loop cortical buttons is still in its early stages. Current evidence is largely limited to biomechanical testing and small-scale clinical studies, leaving a gap in knowledge regarding long-term functional outcomes and complication rates. Furthermore, the

technique requires precise surgical execution to avoid over-tensioning or under-tensioning the tendon, which could compromise repair integrity.

However, as the technology matures and more robust clinical data become available, adaptive loop cortical buttons may emerge as a standard option for distal biceps tendon repair, particularly in complex or retracted cases where traditional fixation methods may fall short. Continued research and surgeon training will be essential to fully realize the potential of this innovative approach.

Comparative Effectiveness. While surgical treatment is widely recognized for providing superior functional and cosmetic outcomes, conservative management remains a viable alternative for select patients, particularly those with lower physical demands or significant medical comorbidities. Surgical repair is often the preferred choice for active individuals and younger patients who require full restoration of strength and endurance, as it is associated with better recovery of flexion and supination strength, reduced long-term disability, and improved patient-reported outcomes.

However, conservative treatment can be an appropriate option for older patients, those with sedentary lifestyles, or individuals with contraindications to surgery. This approach focuses on pain management, physical therapy, and gradual functional rehabilitation, offering satisfactory results for those willing to accept a degree of strength and endurance loss. For such patients, the ability to avoid surgical risks, such as infection, nerve injury, or anesthesia-related complications, can be a decisive factor.

The choice of treatment should be guided by a comprehensive evaluation of individual patient factors, including overall health, activity level, occupation, and personal preferences. For instance, patients engaged in physically demanding work or sports are more likely to benefit from the functional restoration provided by surgery. Conversely, patients with multiple comorbidities, limited mobility, or low functional demands may find conservative management more practical and less invasive.

Shared decision-making is critical in this process. Patients should be informed about the expected outcomes, potential complications, and rehabilitation requirements associated with both treatment modalities. By tailoring the approach to the specific needs and goals of each patient, clinicians can ensure that the chosen management strategy aligns with the individual's medical and personal circumstances, ultimately leading to better satisfaction and quality of life.

Conclusion. Surgical treatment of distal biceps tendon ruptures provides superior functional and cosmetic outcomes, making it the gold standard for younger, active patients. Conservative management, involving rest, NSAIDs, and physical therapy, is suitable for patients with lower physical demands or significant comorbidities but often results in strength and endurance deficits. Among surgical techniques, the single-incision method is cosmetically advantageous but poses neurovascular risks, while the two-incision method offers better visualization with increased soft-tissue trauma risk. Arthroscopic repairs are minimally invasive with favorable outcomes but require advanced training and equipment. Cortical button fixation is the preferred method due to its biomechanical strength, with adaptive loop buttons emerging as a promising innovation. Treatment decisions should be

individualized, considering patient health, lifestyle, and preferences. Further research is needed to optimize techniques and validate emerging approaches.

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СУЧАСНІ ПОГЛЯДИ НА ЛІКУВАННЯ РОЗРИВУ ДИСТАЛЬНОГО СУХОЖИЛЛЯ БІЦЕПСА

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Анотація. *У статті розглядаються сучасні підходи до лікування розриву дистального сухожилля біцепса (DBTR), порівнюючи консервативні та хірургічні методи. Висновки ґрунтуються на систематичному аналізі останніх досліджень, що підкреслюють*

перевагу хірургічного втручання, особливо у молодих і фізично активних пацієнтів. Консервативне лікування обговорюється як прийнятний варіант для пацієнтів старшого віку або осіб із супутніми захворюваннями, з акцентом на його обмеження в відновленні сили та витривалості. У статті також аналізуються різні хірургічні техніки, зокрема однорозрізний, дворозрізний та артроскопічний підходи, а також методи фіксації, такі як кортикальні кнопки та шовні якорі. Представлено нові тенденції в техніках фіксації, зокрема перспективи адаптивних кортикальних кнопок. У дослідженні зроблено висновок, що хірургічне лікування залишається кращим методом для більшості пацієнтів, однак індивідуалізований підхід із урахуванням особливостей пацієнта забезпечує оптимальні результати.

***Ключові слова**: двоголовий м'яз плеча; травми сухожилків; консервативне лікування; хірургічне лікування; рефіксація сухожилля; сухожилля біцепса.*