

General

Decreased Strength, Complication Rate and Higher Satisfaction in Conservative Treatment of Partial Distal Biceps Tendon Rupture Compared to Surgical Treatment: A Systematic Review

Haleigh M Hopper, BS¹, Chase T Nelson, BS¹, Luke A Sandoval, BS¹, John W. Cyrus, MS², James R Satalich, MD³, Conor N O'Neill, MD⁴, Alexander R Vap, MD⁵

¹ School of Medicine, Virginia Commonwealth University, ² Virginia Commonwealth University School of Medicine, ³ Orthopaedic Surgery, Virginia Commonwealth University Medical Center, ⁴ Orthopaedic Surgery, Duke University Health System, ⁵ Orthopaedic Surgery, Virginia Commonwealth University Medical Center

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Background

Treatment modalities for partial distal biceps tendon (DBT) ruptures include conservative management (immobilization, medication, and physical therapy) or surgery. Selecting treatment modality can present a challenge to both patient and provider.

Hypothesis

It was hypothesized that patients undergoing surgical treatment for partial DBT rupture would have higher complications but better overall strength, range of motion (ROM), and patient satisfaction.

Study Design

Systematic Review

Methods

A systematic review was performed in adherence to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Cochrane, Embase, and Medline databases were searched for studies published through May 2023. Studies were included if they examined patients with a partial DBT rupture who underwent treatment. Exclusion criteria were non-human studies, studies not in English, reviews, technical notes, letters to the editor, surgical technique papers, and studies reported in a prior review.

Results

13 studies consisting of 290 patients with a partial DBT tear were included in this review. 75% of the patients were male and the ages ranged from 23 – 75 years. The follow up for the patients ranged from 1 – 94 months. 55 patients underwent conservative treatment versus 256 patients underwent surgical treatment. Outcomes examined by the studies included pain, strength, range of motion (ROM), complications, patient reported outcomes (PROs), return to activity, and patient satisfaction.

Conclusion

Treatment for partial DBT tear via surgery or conservative treatment both produce good clinical outcomes. There are similar outcomes between treatment options for pain and ROM. Conservative treatment had some poorer outcomes in terms of strength after treatment. Surgical treatment had more complications and a few patients with decreased satisfaction. Overall, both are viable treatment options, requiring a physician and patient discussion regarding the pros and cons of both options as a part of a shared decision-making process that incorporates patient priorities.

What is known about the subject: There was a previous systematic review by Behun et al (2016) that reported on surgical outcomes after partial distal biceps tendon tear.

What this study adds to existing knowledge: This systematic review includes more recent studies as well as comparing studies that use surgical and conservative treatment for partial distal biceps tendons tear.

INTRODUCTION

Distal biceps tendon (DBT) ruptures are an uncommon injury typically seen in the dominant arm of male patients.¹ The most common mechanism of injury is due to a loaded eccentric contraction while in a flexed-to-extended position.² Complete tears are more common, though partial tears of the tendon exist.³ In addition to acute traumatic causes, partial rupture is caused by chronic degeneration in the setting of decreased vascularity and excessive friction.⁴ Diagnosis of partial tears requires investigation such as imaging, while complete tears are diagnosed relatively simply using reliable clinical tests such as the hook test.^{2,5}

Treatment modality is typically chosen according to the severity of the partial rupture. Two treatment modalities for partial DBT ruptures include conservative management or surgery. Conservative treatment involves immobilization, medication, and physical therapy, while surgical correction is typically followed by postoperative rehabilitation.⁴ More severe ruptures that include greater than 50% of tendon thickness, young and active patients, as well as patients with less than 50% thickness rupture but who fail to have function restored after conservative management will typically undergo surgery.^{3,6}

Selecting treatment modality can present a challenge to both patient and provider as both treatment modalities have pros and cons to be considered. As such, evidence regarding outcomes of conservative and surgical management should be considered when deciding treatment options. A 2016 systematic review reported on outcomes after surgery for partial rupture DBT, however it did not examine conservative treatment options.⁷ The purpose of this systematic review was to discover the consensus of the literature regarding partial DBT rupture management and compare the outcomes of conservative versus surgical treatment modalities. It was hypothesized that patients undergoing surgical treatment for partial DBT rupture would have higher complications but better overall strength, range of motion (ROM), and patient satisfaction.

METHODS

STUDY ELIGIBILITY

Studies were included if they examined patients with a partial DBT rupture who underwent treatment. Non-human studies and studies not in English were excluded. Papers were also excluded if they were reviews, technical notes, letters to the editor or a surgical technique paper. The study was excluded from analysis if it was reported in a prior review or did not specify outcomes for partial tears.

LITERATURE SEARCH

Cochrane, Embase and Medline were searching for studies published prior to May 31st, 2023, using the search criteria in [Table 1](#) with the assistance of a medical librarian. The search was conducted using the following terms and controlled vocabulary: partial, distal biceps tear, and treatment. Identified studies were uploaded to Covidence (Covidence systematic review software) and duplicate publications were removed.⁸ Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards guided the literature search and review.

STUDY SELECTION AND DATA ABSTRACTION

Screening was performed using the Covidence software by two independent reviewers (H.H., C.N.). Any disagreements were reviewed by a third reviewer to make a final decision (J.S.). Full text screening was completed using the same process. Data was extracted by one of the reviewers then checked by another reviewer before discussing any discrepancies. Patient demographics, including sex, age, and follow up were recorded for each study. The treatment modality, conservative or surgical, as well as the details of treatment were collected. Lastly, outcomes were recorded, including complications, strength, pain, range of motion (ROM), patient reported outcomes (PROs), return to activity, and patient satisfaction.

RISK OF BIAS ASSESSMENT

Risk of bias was assessed using JBI's Methodological Quality Assessment Tool. Critical appraisal checklists for case series, cohort, and case report were used to determine the methodological quality of each study. Two reviewers independently assessed each included study. Discrepancies were discussed and settled by a third reviewer if necessary ([Table 2](#)).

DATA ANALYSIS

The primary focus was outcomes after treatment for partial DBT rupture, which included complications, strength, pain, ROM, patient reported outcomes (PROs), return to activity, and patient satisfaction. Return to activity was recorded as yes or no and indicated the time to return to activity. Pain presence, severity, timing, and location was reported. Strength was reported by manual muscle testing or a dynamometer. Any postoperative complications were recorded. Range of motion was reported in degrees with the time of testing included. PROs included the Oxford Elbow Score questionnaire, Disabilities of the Arm, Shoulder, and Hand (DASH), QuickDASH, Patient Rated Elbow Evaluation (PREE), Single Assessment Numeric Evaluation (SANE), and Mayo Elbow Performance Score (MEPS). Patient satisfaction was reported using a numeric scale, Likert scale, or the 36-Item Short Form Health Survey (SF-36)

Table 1. Full Literature Search Strategy

Table 1.1. Search Strategy for Embase on May 31 st , 2023		
ID	Search	Hits
#1	(bicep or biceps).ti,ab,kw.	19534
#2	exp tendon injury/ or (tear or tears or rupture or ruptures or injury or injuries).ti,ab,kw.	1415952
#3	1 and 2	5263
#4	distal.ti,ab,kw.	359755
#5	3 and 4	1270
#6	partial.ti,ab,kw.	65041
#7	5 and 6	161
#8	3 and 6	642

Table 1.2. Search Strategy for PubMed on May 31 st , 2023		
ID	Search	Hits
#1	(bicep[tiab] OR biceps[tiab] OR bicep[ot] OR biceps[ot]) AND partial AND (tendon injuries[MeSH Terms] OR tear OR tears OR rupture OR ruptures OR injury OR injuries)	541
ID	Search	Hits
#1	(bicep[tiab] OR biceps[tiab] OR bicep[ot] OR biceps[ot]) AND partial AND (tendon injuries[MeSH Terms] OR tear OR tears OR rupture OR ruptures OR injury OR injuries)	541

Table 1.3. Search Strategy for Cochrane on May 31 st , 2023		
ID	Search	Hits
#1	bicep OR biceps	2165
#2	MeSH descriptor: [Tendon Injuries] explode all trees	2230
#3	tear OR tears OR rupture OR ruptures OR injury OR injuries	88466
#4	#2 OR #3	89426
#5	#1 AND #4	489
#6	partial	39843
#7	#5 AND #6	53

RESULTS

1,236 studies were identified by the literature search for screening (Figure 1). After screening, 13 studies met all inclusion and exclusion criteria to be included in the review.⁹⁻²¹ Risk of bias assessment was performed on all 13 studies, and all were deemed suitable for inclusion.

There was a total of 290 patients with a partial DBT tear across the 13 studies (Table 3). 75% of the patients were male and the ages ranged from 23 – 75 years. The follow up for the patients ranged from 1 – 94 months.

55 patients across five studies underwent conservative treatment.^{11,14,15,18,21} Conservative treatment included immobilization, physical therapy, and medical management (Table 4). Outcomes after conservative treatment are summarized in Table 5.

256 patients across 11 studies underwent surgical treatment.^{9-17,19,20} The surgical technique varied in timing, technique, and post-operative protocol (Table 6). Outcomes after surgical treatment are summarized in Table 7.

PAIN

No pain was reported after conservative treatment for the three patients in López-Zabal et al and Giombini et al.^{18,}

²¹ Lee et al showed improvement of average VAS pain score from 6.75 ± 0.96 before conservative treatment to 2.00 ± 0.82 after versus 6.66 ± 1.67 before surgical treatment to 2.40 ± 1.51 after.¹⁵ Bauer et al showed no significant difference in median PREE pain scores between the conservative, delayed surgery, and immediate surgery groups ($p=0.66$).¹¹ Berthold et al reported an ASES pain score for the conservative group as 34.4 ± 16 and 42.5 ± 10.1 for the surgical group.¹⁴ Rao et al reported that the postoperative pain for their surgical patient was 0.2 on a 10-point scale.¹²

STRENGTH

López-Zabala et al reported that the two patients studied that underwent conservative treatment had a subjective decrease in strength in forearm supination and elbow flexion.¹⁸ Robbrecht et al compared the operative arm strength to the uninjured arm strength using a dynamometer and found that the flexion ratio was 0.94 ± 0.15 and supination ratio was 0.9 ± 0.2 .⁹ Ozasa et al and Aggarwal et al reported that the two patients in their respective case studies that underwent surgical treatment both regained full strength.^{17,20}

Table 2. Risk of Bias Assessment using JBI Methodological Quality Assessment Tool

Study	Study Type (LoE)	1	2	3	4	5	6	7	8	9	10	11	SCORE
Robbrecht et al ⁹	Case Series (IV)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y		9
Schmidt et al ¹⁰	Case Series (IV)	Y	Y	Y	Y	N	N	Y	Y	Y	Y		8
Bauer et al ¹¹	Case Series (IV)	Y	Y	Y	Y	N	Y	N	Y	Y	Y		8
Rao et al ¹²	Case Series (IV)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		10
Wörner et al ¹³	Cohort Study, retrospective (III)	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	10
Berthold et al ¹⁴	Cohort Study, retrospective (III)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	11
Lee et al ¹⁵	Case Series (IV)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		10
Voleti et al ¹⁶	Case Series (IV)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y		9
Ozasa et al ¹⁷	Case Report (IV)	Y	Y	Y	Y	Y	Y	Y	Y				8
López-Zabala et al ¹⁸	Case Series (IV)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		10
Bradshaw et al ¹⁹	Case Series (IV)	Y	Y	Y	Y	N	Y	N	Y	Y	Y		8
Aggarwal et al ²⁰	Case Report (IV)	Y	Y	Y	Y	Y	Y	Y	Y				8
Giombini et al ²¹	Case Report (IV)	Y	Y	Y	Y	Y	Y	Y	Y				8

RANGE OF MOTION

López-Zabala et al and Giombini et al reported that their three patients regained FROM after conservative treatment.^{17,21} Berthold et al reported similar ranges of motion after treatment for the conservative and surgical groups for active elbow flexion, extension, supination, and pronation.¹⁴ However, average elbow flexion and extension were below normal for both groups (CDC). Robbrecht et al reported lower values compared to normal for elbow flexion, extension, and pronation after surgery.^{9,22} Worner et al reported an average postoperative elbow flexion that was less than normal.^{13,22} Voleti et al and Ozasa et al showed that all four patients regained FROM after surgery.^{16,17} Bradshaw et al reported that a 10-degree flexion contracture persisted in the one patient with an interosseus suture fixation.¹⁹

COMPLICATIONS

There were no complications notes in any of the conservative studies.^{11,14,15,18,21} Schmidt et al reported 30 complications in their 74 cases.¹⁰ There were 17 lateral antebrachial cutaneous nerve neuropraxias (23%), four radial

sensory nerve neuropraxias (5%), three hematomas (4%), two reruptures (3%), two heterotopic ossifications (3%), one deep infection (1%), and one implant irritation (1%).¹⁰ There were six reoperations (8%) in five patients for rerupture, rerupture and deep infection, heterotopic ossification, and implant removal.¹⁰ Bauer et al reported three revisions (4%) and 12 lateral antebrachial cutaneous nerve paresthesia (16%).¹¹ Worner et al had 12 heterotopic ossification (20%), five reruptures (8%), nine lateral antebrachial cutaneous nerve neuropraxia (15%), and one transient posterior interosseous nerve palsy (2%).¹³ Berthold et al had two cases of lateral antebrachial cutaneous nerve neuropraxia that resolved with time (9%) and 1 required revision surgery (5%).¹⁴

PATIENT REPORTED OUTCOMES

Bauer et al reported no difference in PREE median scores between conservative (5; range: 0-57.33), immediate surgery (5.66; range:0-68), and delayed surgery (1; range:0-24.66) ($p=0.59$).¹¹ The median PREE score in the surgical cases in Schmidt et al was 1.¹⁰ Berthold et al showed a DASH score of 4.8 ± 6.5 in the conservative group and 5.2 ± 8.6 postoperative in the surgical group which was

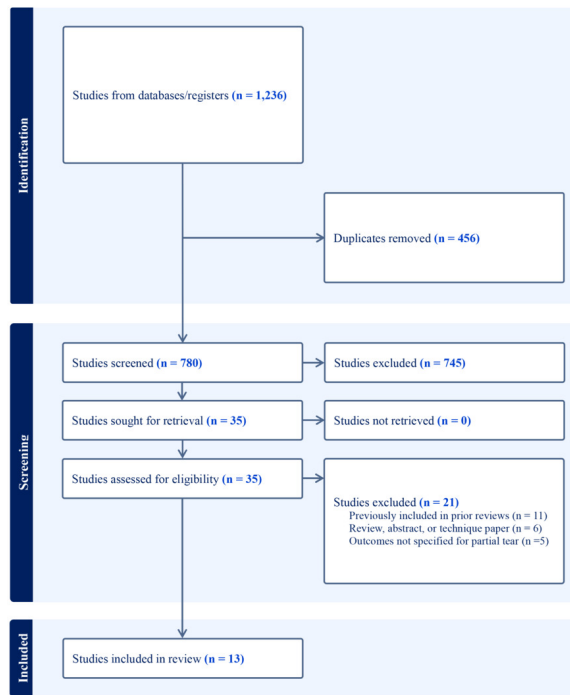


Figure 1. Inclusion and exclusion criteria utilized according to PRISMA guidelines.

significantly better than preoperative ($p < 0.01$).¹⁴ In Ozasa et al the DASH score went from 48.3 preoperative to 0 postoperative.¹⁷ Rao et al had a postoperative DASH median of 10.3.¹² QuickDASH was used in Schmidt et al and showed statistically significant improvement in score postoperative compared to preoperative ($p < 0.05$).¹⁰ However, Schmidt et al also showed worse scores for patients who had to undergo reoperation for QuickDASH and PREE.¹⁰ López-Zabala et al reported MEPS scores of 100 for both conservatively treated patients.¹⁸ Rao et al reported a median MEPS of 100 for the surgically treated patients.¹² Ozasa et al had a preoperative MEOS of 70 then went up to a 100 postoperatively.¹⁷ SANE was used in Berthold et al and was significantly improved from preoperative to postoperative (94.2 ± 5.9 ; $p < 0.01$).¹⁴ Robbrecht et al reported an Oxford Elbow Score questionnaire score of 43.6 ± 6.6 for the surgically treated patients.⁹

RETURN TO ACTIVITY

The two studies that reported return to activity with conservatively treated patients reported that all three of their patients were able to return to activity.^{18,21} There was one patient in Robbrecht et al who was unable to return to their same job after surgery however in the rest of the surgical studies that reported return to activity all five patients were able to return to activity after surgery.^{9,16,17,20}

PATIENT SATISFACTION

Bauer et al reported that there was no statistically significant difference in patient satisfaction between those who underwent immediate surgery and those that failed con-

servative treatment prior to surgery ($p=0.854$).¹¹ Berthold et al used the SF-36 physical and mental subscales.¹⁴ They found that operative group scores improved from preoperative to follow-up for the physical and mental subscales.¹⁴ The post treatment physical subscale score was higher in the surgical group while the mental subscale score was higher in the conservative group.¹⁴ One patient in Rao et al reported they would not undergo surgery again but across the surgical cases the satisfaction was a 9.7 on a 10-point scale.¹² There was one surgical patient in Lee et al that had poor satisfaction versus zero patients in the conservative group.¹⁵ The two conservatively treatment patients in López-Zabal et al had good satisfaction and the one patient in Giombini et al had excellent satisfaction.^{18,21} The two patients that were surgically treated in Ozasa et al and Aggarwal et al both reported excellent satisfaction.^{17,20}

DISCUSSION

After review of the 13 studies included in this systematic review, there are two viable ways to treat a partial DBT tear: conservative or surgical. Although the reporting of outcomes was not standardized across studies, general trends can be elucidated from the results. Overall, there were less complications in the conservatively treated patients, better strength outcomes in the surgically treated patients, and comparable outcomes for pain, ROM, PRO, return to activity, and patient satisfaction between both groups. This supports the initial hypothesis that surgical treatment would result in more complications and better strength, however, rejects the hypothesis that surgical treatment would yield improved ROM and patient satisfaction.

All studies that examined pre and post treatment pain demonstrated a decrease in pain after treatment regardless of modality. Likewise, ROM was either fully restored after treatment or reported slight deficits remaining after both conservative and surgical treatment.^{9,13,14,16-19,21} These improvements could be due to optimizing physical therapy plus medication regimens that ameliorate pain and improve functionality.

In terms of strength, the conservative studies reported a decrease in strength,¹⁸ while the surgical studies boasted a restoration of strength^{17,20} and symmetry between surgical and uninjured arms.⁹ Morrey et al reported a decrease in supination and flexion strength for those undergoing conservative treatment however this was in complete DBT rupture not partial tears.²³ Freeman et al also reported decreased strength after conservative treatment, however these did not seem to impact PROs as the same study reported PROs were still satisfactory to patients.²⁴ The dichotomy of strength deficits and satisfactory diminished PROs could be due to them being slight or minimal strength deficits, or due to compensatory musculature. Additionally, functional strength may be preserved by the intact portion of the tendon at its insertion site.

There were no complications in the conservative treatment, however in the surgical group there was lateral antebrachial cutaneous nerve neuropraxias (range: 9-23%), rerupture (range: 3-8%), heterotopic ossification (range:

Table 3. Patient Demographics

Study	Study Type (Level)	N	Treatment Type (n)	Total procedures (n)	Female (n)	Male (n)	Age (Mean $\pm$ SD, Range)	Follow-Up (Mean $\pm$ SD, Range)
Robbrecht et al ⁹	Case Series (IV)	43	Conservative: 0 Surgical: 43	28	5	20	53.5 $\pm$ 9.2 yrs	6.8 $\pm$ 4.1 yrs (overall) *
Schmidt et al ¹⁰	Case Series (IV)	56	Conservative: 0 Surgical: 56		14	42		46 mo. (range 15-85)
Bauer et al ¹¹	Case Series (IV)	74	Conservative: 27 Surgical: 47		9	68	51.6 yrs	
Rao et al ¹²	Case Series (IV)	14	Conservative: 0 Surgical: 14	14			56.1 yrs (range: 34.3-72.7) *	3 months minimum
Wörner et al ¹³	Cohort Study, retrospective (III)	59	Conservative: 0 Surgical: 59	62	9	50	49.9 $\pm$ 1.2 yrs	Median: 14 months (range: 1-82)
Berthold et al ¹⁴	Cohort Study, retrospective (III)	22	Conservative: 21 Surgical: 22		2	20	47.8 $\pm$ 11.5 yrs No significant difference between partial & complete. *	4.1 $\pm$ 3.8 yrs for operative 2.2 $\pm$ 2.9 yrs for non-op No significant difference between partial & complete. *
Lee et al ¹⁵	Case Series (IV)	9	Conservative: 4 Surgical: 5		2	7	56 $\pm$ 8.5 yrs (range: 39-64)	
Voleti et al ¹⁶	Case Series (IV)	3	Conservative: 0 Surgical: 3	3	0	3	38 $\pm$ 13.8 yrs (range: 23-58)	
Ozasa et al ¹⁷	Case Report (IV)	1	Conservative: 0 Surgical: 1	1		1	58 yrs	6 yrs
López-Zabala et al ¹⁸	Case Series (IV)	2	Conservative: 2 Surgical: 0	0		2	49.5 yrs (range: 48-51)	1 yr.
Bradshaw et al ¹⁹	Case Series (IV)	5	Conservative: 0 Surgical: 5	5	3	2	52 $\pm$ 14 yrs (range: 34-75)	39 $\pm$ 33.2 months (range: 6-94)
Aggarwal et al ²⁰	Case Report (IV)	1	Conservative: 0 Surgical: 1	1		1	64 yrs	12 months
Giombini et al ²¹	Case Report (IV)	1	Conservative: 1 Surgical: 0			1	27 yrs	12 months
Total:		290	Conservative: 55 Surgical: 256		47	217	Range: 23-75 yrs	Range: 1-94 months

*authors did not report values for partial tears only therefore whole-study values were used

Table 4. Conservative Treatment Details

Study	N	Immobilization	Physical Therapy	Medical Management	Other
Bauer et al ¹¹	27				
Berthold et al ¹⁴	21	Shoulder sling (2-4 weeks)	Focused on wrist & elbow strength	NSAIDs for pain control & swelling	Return to activity as tolerated
Lee et al ¹⁵	4	Long arm splint (3 weeks)	Performed with NSAIDs	NSAIDs for pain control & swelling	Steroid injections (3/4)
López-Zabala et al ¹⁸	2	Shoulder sling (3 weeks)			
Giombini et al ²¹	1	Immobilized (4 weeks)	Progressive strengthening exercises (7 weeks)		Hyperthermia system with deep heating & superficial cooling via microwaves. (3 times per week, concurrent with immobilization)
TOTAL	55				

3-20%), and reoperation (range: 4-8%) in the surgical group.^{10,11,13,14} These types of complications are like those noted in a systematic review by Behun et al.⁷ Ruch et al compared complications after surgical treatment of partial and complete DBT tears and found that the percentage of patients with nerve palsy was higher in the partial tear group.²⁵ However, that study reported rates of 57% lateral antebrachial cutaneous nerve neuropraxia and 20% posterior interosseous nerve palsy in the partial tendon group which is higher than rates reported in any of the studies included in this systematic review.²⁵ There is a paucity of data regarding surgical complication rates for surgery for partial rupture of DBT. However, the complication rates for surgery after complete DBT tear have been more thoroughly studied and show that rates differ based on surgical approach.²⁶ In a meta-analysis by Amin et al they found that double incision approach to a complete biceps tear produced lower complication rates than a single incision but the rate of complications is lower than our reported rates for rerupture.²⁶ A similar systematic review by Amarasooriya et al found lower rates of complication for repair of a complete DBT tear for posterior interosseous nerve palsy and rerupture.²⁷

Overall, PROs improved from preoperative to postoperative scores.^{10,14,17} After conservative or surgical treatment MEPS was always 100.^{12,17,18} DASH scores in the surgical group ranged from 0 to 10.3^{12,14,17} and was 4.8 in the conservative group.¹⁴ The median PREE score was lower in the immediate surgery group (1) compared to the PREE score in the conservative group (5) indicating that there was more pain and functional disability in the conservative group, however this scale ranges from 0 to 100, making a score of 5 low when taken in context.¹¹ Satisfaction in both groups was mostly good to excellent, however there were two patients in the surgical group that reported poor satisfaction.

^{12,15} This is consistent with findings from Behun et al systematic review where many patients who underwent surgical treatment were satisfied with the outcome however a few were not satisfied.⁷ Carter et al similarly reported optimal outcomes after repair but cited persistent nerve injury as a source of dissatisfaction.²⁸ Therefore, the increase in complications following surgical treatment could explain the higher number of dissatisfied patients in the surgical group compared to the nonoperative group.

One of the major considerations of conservative treatment is that the patient could potentially still require surgery if conservative treatment fails. 38/56 (68%) and 34/47 (72%) of surgical patients in Schmidt et al and Bauer et al respectively, underwent surgery because they had failed conservative treatment.^{10,11} The five patients in Lee et al and one patient in Ozasa et al all underwent surgery after six months of trying conservative treatment.^{15,17} This delay in surgery could potentially increase the risk of complications as well as prolong a patients road to recovery, increase resource utilization, and total healthcare burden to the patients.^{29,30} Cain et al found that earlier surgical intervention provided better outcomes because there were less complications when surgery was performed within four weeks of injury.²⁹ Similar findings were reported in Kelly et al where they report that the longer a surgery was delayed, the higher the complication rate.³⁰ The delay would also prevent the patient from returning to activity sooner and could contribute to poor patient satisfaction after surgery. However, both studies were examining complete distal bicep tendons ruptures and these complications due to delay of surgery could be due to retraction of the tendon away from the initial insertion.²³

Table 5. Conservative Treatment Outcomes

Study	n	Pain	Strength	ROM	Complications	PRO	Return to Activity	Patient Satisfaction
Bauer et al ¹¹	27	PREE pain subscale median = 2 (range: 0-36)				PREE: Median = 5 (range: 0-57.33)		
Berthold et al ¹⁴	21	ASES pain score: 34.4 ± 16		Active flexion: Non-op: 126.5 ± 5.9 Active extension: Non-op: 0.5 ± 1.5 Active supination: Non-op: 88.9 ± 2.6 Active pronation: Non-op: 87.8 ± 6.6		DASH Non-op: 4.8 ± 6.5		SF-36 Health component Physical: 49.0 ± 8.8 Mental: 55.2 ± 5.8
Lee et al ¹⁵	4	Pre VAS: 6.75 ± 0.96 Post (6 months) VAS: 2.00 ± 0.82						0 poor 1 good 2 very good 1 excellent
López-Zabala et al ¹⁸	2	No pain	2/2 subjectively decreased from normal in supination & elbow flexion but not quantified	FROM at 1 year post-op		2/2 MEPS: 100	Both patients were recreationally active & RTA after 3 week immobilization	Good
Giombini et al ²¹	1	No pain		Returned to full active range of motion at 10 weeks			Yes	Excellent
Total:	55							

Abbreviations: ROM = Range of Motion, FROM = full range of motion, PRO = Patient-reported Outcomes, Pre-Op = preoperative, Post-Op = postoperative, RTA = return to activity, PREE = Patient-Rated Elbow Evaluation, SANE = Single Assessment Numeric Evaluation, DASH = Disabilities of the Arm, Shoulder and Hand, ASES = American Shoulder and Elbow Surgeons, VAS = Visual Analogue Scale, MEPS = Mayo Elbow Performance Score

LIMITATIONS

This study is limited by heterogenous data resulting in barriers to objectively comparing and analyzing results between studies. Pain was reported subjectively and using the PREE subscale, ASES pain score, and VAS scale. Strength was reported subjectively and with a dynamometer. Patient satisfaction was reported using the SF-36 Health component, a 10-point scale and a scale from poor to excellent. There was also a lack of direct comparison of surgical to

conservative treatment in most of the studies therefore no statement could be made on the statistical significance in any observed differences. The wide ranges of follow up times could impact the reported outcomes if there was insufficient time to capture certain complications. In addition, patient comorbidities and activity level weren't controlled in the studies therefore they could confound the results.

Table 6. Surgical Treatment Details

Study	N	Timing	Technique	Post-op Protocol
Robbrecht et al ⁹	43	Within 2 weeks of diagnosis – 43	Transcortical suspension	Casted for 1 week, then progressive mobilization brace
Schmidt et al ¹⁰	56	After failed conservative treatment – 38 Immediate – 18 Median = 6 months (IQR: 2 - 8)	Endobutton or Ziploop	Orthosis, brace after 1-2 weeks
Bauer et al ¹¹	47	After failed conservative treatment – 34 Immediate – 13 Median = 69 days (range: 4 - 561)	Approach: Anterior: 33 (20 delayed + 13 immediate) Posterior: 16 (15 delayed + 1 immediate) 2 Incisions: 22 (18 delayed + 4 immediate) Technique: FiberWire/Krackow, Endobutton, Anchor	
Rao et al ¹²	14	Median = 46.5 days (range: 7 - 972)	Incisions: Single – 11 Double – 3 Technique: Bone Tunnel – 5 Suture/Button – 9 Interference Screws – 3 Other – 2	Varied by surgeon preference
Wörner et al ¹³	59		Endobutton – 41 Graft used – 4 Suture Anchor – 21	Casted for 1 week NSAIDs – 1-3 weeks Physical therapy after 1 week Normal activities after 3 months
Berthold et al ¹⁴	22		Endobutton or suture anchor	Splinted for 3-5 days, followed by compression sleeve Physical therapy after 1 week Normal activities after 4 weeks
Lee et al ¹⁵	5	Performed after at least 6 months of failed conservative treatment	Approach: Anterior – 3 2 Incisions – 2 Technique: Suture Anchor – 5	Casted for 6 wks. Physical therapy began after 6 weeks Strengthening exercises after 3 mo.
Voleti et al ¹⁶	3		Suture anchor – 2 Intramedullary button – 1	For one patient: Immobilizing brace for 2 weeks then physical therapy with full extension by 6 weeks then strengthening exercises after 3 months
Ozasa et al ¹⁷	1	6 months (after failed conservative treatment)	Suture anchor (with graft)	Sling for a few days with immediate physical therapy Full ROM by 3 weeks Heavy labor by 3 months
Bradshaw et al ¹⁹	5	2- 18 months of symptoms prior to treatment	Biopsy only – 4 Biopsy with interosseus fixation – 1	
Aggarwal et al ²⁰	1	4 weeks	Transosseous Arthrex biceps button after whip-stitching ruptured tendon.	
TOTAL	256			

Table 7. Surgical Treatment Outcomes

Study	n	Pain	Strength	ROM	Complications	PRO	Return to Activity
Robbrecht et al ⁹	43		Force (N) degrees Flexion: 271.51 ± 65.9 Flexion ratio injured/opposite: 0.94 ± 0.15. Supination: 48.5 ± 14.8 Supination ratio injured/opposite: 0.9 ± 0.2	Elbow flexion: 140.6 ± 3.9 Elbow extension: 1.2 ± 4.9 Pronation: 75.9 ± 11.4 Supination: 86.5 ± 10.3		Oxford Elbow Score questionnaire = 43.6 ± 6.6	42/43 returned to same job after rehabilitation 6.8 ± 5.4 weeks of sick time
Schmidt et al ¹⁰	56				17 (23%) lateral antebrachial cutaneous nerve neuropraxias 4 (5%) radial sensory nerve neuropraxias 3 (4%) hematomas 2 (3%) reruptures 2 (3%) heterotopic ossifications 1 (1%) deep infection 1 (1%) implant irritation 6 (8%) reoperations in 5 patients Total = 30 *Related to all 74 tears eligible for the study not only the 56 that were reached for follow-up	PREE median: 1 QuickDASH median: 2.3 Change in QuickDASH from pre-op to post-op median: 40.9 (p < 0.05) 5 patients that underwent a reoperation: PREE median = 4.7 QuickDASH median = 13.6	
Bauer et al ¹¹	47	PREE pain subscale median (range) Delayed: 3 (0-42) Immediate: 0 (0-22)			3/74 (4%) revision repair 12/74 (16.2%) lateral antebrachial cutaneous nerve paresthesia	PREE: Median delayed = 5.66 (range: 0-68) Median immediate = 1 (range: 0-24.66)	
Rao et al ¹²	14	0-10 scale median Post-op: 0.2				MEPS: 100 DASH: 10.3	
Wörner et	59			Elbow flexion 130.4 ±	12 (20%)		

Study	n	Pain	Strength	ROM	Complications	PRO	Return to Activity
al ¹³				3.0 p = 0.2 between suture anchor & endobutton groups	heterotopic ossifications 9 (15%) lateral antebrachial cutaneous nerve neuropraxia palsy 5 (8%) rerupture 1 (2%) transient posterior interosseous nerve palsy		
Berthold et al ¹⁴	22	ASES Pain score 42.5 ± 10.1		<u>Active flexion:</u> Operative: 127.9 ± 8.0 <u>Active extension:</u> Operative: 0 ± 0 <u>Active supination:</u> Operative: 90 ± 1.4 <u>Active pronation:</u> Operative: 75.8 ± 11.6	2 (9%) neurological symptoms of the lateral antebrachial cutaneous nerve that resolved with time. 1 (5%) revision surgery for rerupture	<u>SANE:</u> Operative: 94.2 ± 5.9 (p < 0.01 compared to pre-op) <u>DASH:</u> Operative: 5.2 ± 8.6 (p < 0.01 compared to pre-op)	
Lee et al ¹⁵	5	Pre-op VAS: 6.66 ± 1.67 Post-op (6 mo.) VAS: 2.40 ± 1.51					
Voleti et al ¹⁶	3			FROM by 6 weeks post-op			Yes at 8, 5, and 4 months
Ozasa et al ¹⁷	1	No pain	No weakness	FROM		<u>Pre-op:</u> MEPS: 70 DASH: 48.3 <u>Post-op:</u> MEPS: 100 DASH: 0	Yes at 3 months
Bradshaw et al ¹⁹	5			In patient with reconstruction via interosseous suture fixation- 10° flexion contracture remained			
Aggarwal et al ²⁰	1		strength restored by 3 months				Yes
Total:	256						

Abbreviations: ROM = Range of Motion, FROM = full range of motion, PRO = Patient-reported Outcomes, Pre-Op = preoperative, Post-Op = postoperative, RTA = return to activity, PREE = Patient-Rated Elbow Evaluation, SANE = Single Assessment Numeric Evaluation, DASH = Disabilities of the Arm, Shoulder and Hand, ASES = American Shoulder and Elbow Surgeons, VAS = Visual Analogue Scale, MEPS = Mayo Elbow Performance Score

CONCLUSION

Treatment for partial DBT tear via surgery or conservative treatment both produce good clinical outcomes. There are

similar outcomes between treatment options for pain and range of motion. Conservative treatment had some poorer outcomes in terms of strength after treatment. Surgical treatment had more complications and a few patients with

decreased satisfaction. Overall, both are viable treatment options, requiring a physician and patient discussion regarding the pros and cons of both options as a part of a shared decision-making process that incorporates patient priorities.

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