



Trends associated with distal biceps tendon repair in the United States, 2007 to 2011



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Background: Current studies investigating surgical treatment of distal biceps tendon tears largely consist of small, retrospective case series. The purpose of this study was to investigate the current patient demographics, surgical trends, and postoperative complication rates associated with operative treatment of distal biceps tendon tears using a large database of privately insured, non-Medicare patients.

Methods: Patients who underwent surgical intervention for distal biceps tendon tears from 2007 to 2011 were identified using the PearlDiver database. Demographic and surgical data as well as postoperative complications were reviewed. Statistical analysis was performed using linear regression analysis and χ^2 tests, with statistical significance set at $P < .05$.

Results: A total of 1443 patients underwent surgical treatment for distal biceps tendon tears. Men and patients aged 40 to 59 years accounted for 98% and 72% of the cohort, respectively. Regarding surgical technique, reinsertion to the radial tuberosity was preferred (95%) over tenodesis to the brachialis (5%) ($P < .01$). In total, revision surgery for tendon rerupture occurred in 5.4% of treated patients. The incidence of revision surgery for rerupture in acute and chronic distal biceps tears was 5.1% and 7.0%, respectively ($P = .36$). Postoperative infection and peripheral nerve injury rates were 1.1% and 0.6%, respectively.

Conclusion: Surgeons strongly preferred anatomic reinsertion to the radial tuberosity for treatment, regardless of the chronicity of the injury. Postoperative complication rates were similar to those found in prior studies, although the true rate of rerupture may be higher than previously thought.

Level of evidence: Level IV; Case Series Using Large Database; Treatment Study

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Distal biceps tendon tears account for 10% of all biceps brachii injuries and, when left untreated, can result in significant weakness and early fatigue with activities that require elbow supination and flexion.²⁸ These injuries occur during sudden eccentric loading of the biceps and are most commonly observed in middle-aged men.^{13,17,27} Early diagnosis

Table I International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and Current Procedural Terminology (CPT) codes used to identify patients surgically treated for distal biceps tendon tears and associated postoperative complications

Diagnosis or procedure	ICD-9-CM or CPT code
Acute distal biceps tendon rupture	ICD-9 841.8
Chronic distal biceps tendon rupture	ICD-9 727.69
Reinsertion of ruptured biceps tendon, distal, with and without tendon graft	CPT 24342
Tenodesis of biceps tendon at elbow	CPT 24340
Postoperative infection/hematoma (débridement procedure)	CPT 10060, 10061, 10140, 10160, 10180, 11000, 11040, 11041, 11042, 11043, 23930, 23920, 23935, 25028, 25028, 25035
Peripheral nerve injury	ICD-9 955.1, 955.2, 955.3, 955.4, 955.5, 955.7, 955.8, 955.9
Compartment syndrome (fasciotomy)	CPT 24495, 25023, 25020, 25024, 25025
Rerupture (reinsertion/tenodesis)	CPT 24342, 24340
Postoperative heterotopic ossification	ICD-9 728.13
Radioulnar synostosis	ICD-9 755.53
Elbow arthrofibrosis (elbow manipulation)	CPT 24300

and anatomic repair of the avulsed tendon to the radial tuberosity are recommended to restore both supination and flexion strength,⁷ although tenodesis to the brachialis has been described as a successful alternative treatment option in select cases.²⁶ Ultimately, surgical decision-making is based on an array of factors, including the age and lifestyle of the patient as well as chronicity of the injury.²⁶

During the last 2 decades, various surgical approaches and tendon fixation techniques have been developed to improve fixation strength, to limit complications, and to allow early functional recovery. However, because of the relative rarity of these injuries, current studies examining surgical treatment and outcomes mostly consist of small retrospective case series.^{2,3,5,7} As such, reported complication rates vary widely. The incidence of nerve injury ranges from 5% to 13%,^{8,10} whereas the rate for heterotopic ossification ranges from 0% to 65%.^{4,25,27} In addition, the incidence of reruptures has been reported from 2% to 8%,^{5,17,20,24} although most studies report zero reruptures in their series.^{14,16,22,23,25} Furthermore, although repair of chronic ruptures is thought to be more susceptible to rerupture because of difficulties with fixation and the need for an interposition allograft, most case series report zero reruptures in their cohort.^{11,12,18,19,31} This has led some authors to suggest under-reporting of this complication.⁸

The purpose of this study was to investigate the current patient demographics, surgical trends, and postoperative complications associated with surgical treatment of distal biceps tendon ruptures using a large national private payer insurance database.

Materials and methods

Patients undergoing surgical treatment for distal biceps tendon tears were identified within the PearlDiver Patient Record Database (PearlDiver Technologies, Warsaw, IN, USA; www.pearldiverinc.com) using a combination of *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) and *Current Procedural Termi-*

nology (CPT) codes (Table I). To our knowledge, this database is the largest private payer database in the United States, with UnitedHealth Group having the largest number of patient records. From 2007 to 2011, the database captured 24.6 to 26.3 million patients, representing approximately 9% of the U.S. population younger than 65 years and approximately 13% of the U.S. population with private insurance, according to data from the U.S. Census Bureau.

To ensure appropriate study inclusion, we used a predetermined algorithm to identify patients treated for distal biceps tendon tears during the study period. Patients were identified using the ICD-9 diagnosis codes for acute (841.8) and chronic distal biceps tendon injury (727.69) in conjunction with the CPT codes for reinsertion with or without graft (24342) or tenodesis to the brachialis (24340) using Boolean search language. Demographic data, which consisted of the patient's gender and age and the year and region in which the patient was treated, were collected.

From this cohort, commonly recognized postoperative complication rates were collected using predetermined ICD-9 and CPT codes (Table I). Postoperative rates for infection/hematoma, peripheral nerve palsy, and compartment syndrome were elicited within 30 days of the index surgery. Patients were recognized as incurring a postoperative infection/hematoma or compartment syndrome if they underwent a surgical débridement or fasciotomy procedure, respectively, in this early postoperative period (within 30 days). Postoperative rates for tendon reinjury, elbow arthrofibrosis, heterotopic ossification, and radioulnar synostosis were elicited within 1 year of the index surgery. Patients were recognized as incurring a recurrent injury or elbow arthrofibrosis if they underwent a revision repair or elbow manipulation procedure, respectively, during the postoperative period (within 1 year).

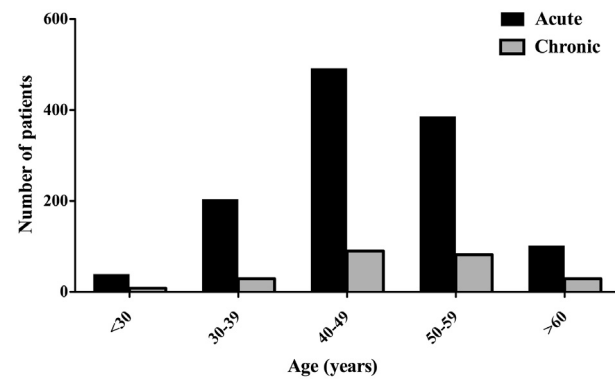
Statistical analysis

Linear regression was used to examine differences in trends over time. The χ^2 test was used to examine the association

Table II Number of patients receiving surgery for acute vs. chronic distal biceps tendon tears

	Acute	Chronic	<i>P</i> value
Procedure			<.01
Reinsertion	1141	232	
Tenodesis	67	3	
Year			.38
2007	192	27	
2008	201	45	
2009	246	52	
2010	281	48	
2011	298	65	
Gender			1.00
Female	27	5	
Male	1181	230	
Region			<.01
Midwest	334	38	
Northeast	161	18	
South	517	140	
West	206	45	
Age			.03
<30	39	8	
30-39	204	29	
40-49	492	90	
50-59	386	82	
>60	102	29	
Total*	1208	235	

* Discrepancies between total value and summation of values in each group are attributed to the transfer of patients between subgroups.

**Figure 1** Patients receiving surgery for acute and chronic distal biceps tendon tears by age group.**Table III** Incidence of postoperative complications

Complication	Incidence (%)
<i>Within 30 days of index surgery</i>	
Postoperative infection/hematoma	1.11
Peripheral nerve injury	0.55
Compartment syndrome	0.14
<i>Within 1 year of index surgery</i>	
Rerupture	5.40
Heterotopic ossification	0.46
Radioulnar synostosis	0.27
Elbow arthrofibrosis	0.18

between categorical variables. Significance was set at the $P < .05$ level.

Results

From 2007 to 2011, a total of 1443 patients underwent surgical treatment for distal biceps tendon tears (Table II). Reinsertion of the distal biceps tendon with or without graft was the preferred treatment option (95%) compared with tenodesis to the brachialis (5%) ($P < .01$). The total number of reinsertion ($P < .01$) and tenodesis ($P = .03$) procedures increased during the study period. However, the proportion of reinsertion to tenodesis procedures remained unchanged during the study period ($P = .38$). Most patients were treated acutely (84%). Among patients classified with a chronic rupture, only 1.2% underwent tenodesis to the brachialis tendon. Men accounted for 98% of patients who were treated with surgery. There was no difference in the ratio of men to women treated for acute vs. chronic ruptures ($P = 1.00$). Patients between 40 and 59 years of age composed 72% of the total number treated with surgery (Fig. 1).

Within 30 days after surgery, the incidence of postoperative infection/hematoma requiring a secondary surgery was 1.11% (Table III). Postoperative peripheral nerve injury and compartment syndrome were rare at 0.55% and 0.14%, re-

spectively. Within 1 year after surgery, the total incidence of revision surgery for rerupture was 5.4%. The incidence of revision surgery for rerupture in acute and chronic injuries was 5.1% and 7.0%, respectively ($P = .36$). Development of heterotopic ossification and radioulnar synostosis was rare at 0.46% and 0.27%, respectively. The incidence of elbow manipulation under anesthesia was 0.18%.

Discussion

The purpose of this study was to investigate the current patient demographics, surgical trends, and postoperative complications associated with surgical treatment of distal biceps tendon ruptures in the United States during a recent 5-year period. Anatomic reinsertion of the distal biceps tendon is widely recognized as the primary treatment option for distal biceps injuries in appropriately indicated patients.^{5,7} In a meta-analysis of 147 tendon tears, good to excellent clinical outcomes were achieved in only 40% of patients who were treated with tenodesis compared with nearly 90% of patients who underwent direct tendon repair to the tuberosity.²⁷ If the tendon cannot be adequately mobilized and reduced to the tuberosity in chronic injuries, interposition grafting has proved to be successful in the majority of patients.^{12,13,18,32} In this study, surgeons in the United States strongly favored tendon reinsertion by direct repair or tendon reconstruction,

regardless of injury chronicity, confirming that tenodesis has fallen out of favor as a treatment option.

As we expected, this study confirms the predominance of distal biceps tendon injuries in middle-aged men. To date, only isolated cases of distal biceps tendon tears have been reported in women.^{6,21,28} This gender pattern may be explained by greater forces per cross-sectional area at the insertion site seen in men.²⁷ However, intrinsic factors related to age, such as hypovascularity and degenerative tendinopathy, may be equally significant contributors to distal biceps tendon ruptures.^{6,30} In a smaller retrospective study of 14 patients, injuries occurred mostly in men (93%) with an average age of 47 years.²⁸ Only 29% of these patients were considered to be athletically active or to have physically demanding occupations at the time of injury, indicating that pre-existing tendinopathy may have been present before tendon rupture.

Cumulative postoperative complication rates vary widely in the literature from 9% to 40%.^{7,8,24,27} Nerve injuries, most commonly involving the lateral antebrachial cutaneous nerve and posterior interosseous nerve, have been reported in 5% to 13% of all repairs.^{8,10} In this study, the incidence of peripheral nerve injury was only 0.55%. This low rate may be attributed to under-reporting by physicians, particularly neurapraxia injuries that are transient or have little functional impact. In addition, physicians may have reported nerve palsies in their clinical documentation but not through ICD coding. The rate of superficial and deep surgical site infections has been reported between 2% and 4%.^{7,20,24} In a cohort of 190 patients who underwent distal biceps repair,²⁰ the incidence of wound débridement for postoperative infection was 1.6%, which is similar to the incidence found in this study (1.1%). There has been only 1 case report of compartment syndrome after distal biceps repair in the literature,¹⁵ which confirms the rarity of this complication. We observed only 2 records of this complication in our study cohort.

We observed a higher rate of reruptures (5.4%) in our cohort than that described in the current literature. In the largest case series to date, Hinchey et al reported a rerupture rate of 1.5% in a review of 190 primary distal biceps tendon repairs during a 28-year period.²⁰ However, similar to our study, operative technique and postoperative management varied throughout the study because of the length of the study period and the number of surgeons involved.²⁰ In a randomized control trial comparing 1- vs. 2-incision techniques, the total rerupture rate was 4.4% in 91 patients, with no difference in rate between the 2 techniques.¹⁷ Several smaller case series describe rerupture rates between 2% and 8%.^{5,9,24} However, most other studies report zero reruptures in their cohorts, including those focusing specifically on chronic ruptures.^{11,12,16,18,22,23,25,29,31,33} Because of the fact that recurrent tendon tears were collected by identifying patients who underwent revision surgery, this study may be less susceptible to under-reporting of this specific complication compared with other studies.

With regard to heterotopic ossification and radioulnar synostosis, reported rates vary between 0% and 65%.^{4,25,27}

compared with <1% for both in this study. This variability may be due to differences in repair technique (single-incision vs. 2-incision), nonsteroidal anti-inflammatory drug prophylaxis, and widespread recognition on the part of surgeons to avoid extensive dissection near the ulna periosteum. As previously noted, under-reporting of these complications may also contribute to the observed rates. Unfortunately, information about use of the 1- vs. 2-incision technique and nonsteroidal anti-inflammatory drug prophylaxis was not available through the PearlDiver database to help determine influence on the observed data.

To our knowledge, this is one of few studies investigating modern trends in the surgical management of distal biceps tendon injuries within the United States. The principal advantage of a study design using a large national database is that it facilitates analysis of widespread trends across multiple centers and providers, thereby providing valuable insight into current demographic and procedural trends. Furthermore, by analyzing a large cohort of patients, this study affords a population size and level of statistical power that is not easily achieved through standard review of patient records. Despite these strengths, there are several limitations to this study. Data on patient medical comorbidities, laterality of injury, surgical technique (1- vs. 2-incision), allograft tissue type, and postoperative protocol were not available through the database. In addition, as with any insurance records database, the results may be subject to errors in coding. Conservative treatment of recurrent tears could not be elicited because of a lack of a specific ICD-9 or CPT code for this diagnosis and management. The database does not include equal representation across the U.S. population, as the southern region is over-represented in the PearlDiver database because of increased penetrance of the UnitedHealth group in southern states relative to other regions of the country, where competitors such as BlueCross, Aetna, and Kaiser Permanente own larger market shares. Last, the database does not include Medicare, Medicaid, workers' compensation, or uninsured populations, and current data suggest clear differences in clinical outcomes after surgical intervention in these patients relative to the general population.¹

Conclusions

In the United States, the majority of patients treated for distal biceps tendon tears were middle-aged men. Surgeons strongly preferred anatomic tendon repair to the radial tuberosity for treatment, regardless of the chronicity of the injury. This is consistent with prior studies demonstrating poor outcomes after tenodesis and good to excellent outcomes after repair with interposition grafting. Postoperative complication rates in this study were similar to those found in other studies, although the true rate of recurrent tendon tears, especially in the setting of chronic injuries, may be higher than previously thought.

Disclaimer

Jeffrey C. Wang holds stock in PearlDiver Technologies. All the other authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

- Atanda A Jr, O'Brien DF, Kraeutler MJ, Rangavajjula A, Lazarus MD, Ramsey ML, et al. Outcomes after distal biceps repair in patients with workers' compensation claims. *J Shoulder Elbow Surg* 2013;22:299-304. <http://dx.doi.org/10.1016/j.jse.2012.11.011>
- Banerjee M, Shafizadeh S, Bouillon B, Tjardes T, Wafaisade A, Balke M. High complication rate following distal biceps refixation with cortical button. *Arch Orthop Trauma Surg* 2013;133:1361-6. <http://dx.doi.org/10.1007/s00402-013-1819-1>
- Baratz M, King GJ, Steinmann S. Repair of distal biceps ruptures. *J Hand Surg Am* 2012;37:1462-6. <http://dx.doi.org/10.1016/j.jhsa.2012.02.008>
- Bell RH, Wiley WB, Noble JS, Kuczynski DJ. Repair of distal biceps brachii tendon ruptures. *J Shoulder Elbow Surg* 2000;9:223-6.
- Bisson L, Moyer M, Lanighan K, Marzo J. Complications associated with repair of a distal biceps rupture using the modified two-incision technique. *J Shoulder Elbow Surg* 2008;17:67S-71S. <http://dx.doi.org/10.1016/j.jse.2007.04.008>
- Bourne MH, Morrey BF. Partial rupture of the distal biceps tendon. *Clin Orthop Relat Res* 1991;143-8.
- Cain RA, Nydick JA, Stein MI, Williams BD, Polikandriotis JA, Hess AV. Complications following distal biceps repair. *J Hand Surg Am* 2012;37:2112-7. <http://dx.doi.org/10.1016/j.jhsa.2012.06.022>
- Chavan PR, Duquin TR, Bisson LJ. Repair of the ruptured distal biceps tendon: a systematic review. *Am J Sports Med* 2008;36:1618-24. <http://dx.doi.org/10.1177/0363546508321482>
- Citak M, Backhaus M, Seybold D, Suero EM, Schildhauer TA, Roetman B. Surgical repair of the distal biceps brachii tendon: a comparative study of three surgical fixation techniques. *Knee Surg Sports Traumatol Arthrosc* 2011;19:1936-41. <http://dx.doi.org/10.1007/s00167-011-1591-0>
- Cohen MS. Complications of distal biceps tendon repairs. *Sports Med Arthrosc* 2008;16:148-53. <http://dx.doi.org/10.1097/JSA.0b013e3181824eb0>
- Cross MB, Egidy CC, Wu RH, Osbahr DC, Nam D, Dines JS. Single-incision chronic distal biceps tendon repair with tibialis anterior allograft. *Int Orthop* 2014;38:791-5. <http://dx.doi.org/10.1007/s00264-013-2182-0>
- Darlis NA, Sotereanos DG. Distal biceps tendon reconstruction in chronic ruptures. *J Shoulder Elbow Surg* 2006;15:614-9. <http://dx.doi.org/10.1016/j.jse.2005.10.004>
- Dillon MT, King JC. Treatment of chronic biceps tendon ruptures. *Hand (N Y)* 2013;8:401-9. <http://dx.doi.org/10.1007/s11552-013-9551-4>
- El-Hawary R, Macdermid JC, Faber KJ, Patterson SD, King GJ. Distal biceps tendon repair: comparison of surgical techniques. *J Hand Surg Am* 2003;28:496-502. <http://dx.doi.org/10.1053/jhsu.2003.50081>
- Grandizio LC, Suk M, Feltham GT. Distal biceps brachii tendon rupture resulting in acute compartment syndrome. *Orthopedics* 2013;36:e1479-81. <http://dx.doi.org/10.3928/01477447-20131021-38>
- Grégory T, Roure P, Fontès D. Repair of distal biceps tendon rupture using a suture anchor: description of a new endoscopic procedure. *Am J Sports Med* 2009;37:506-11. <http://dx.doi.org/10.1177/0363546508326985>
- Grewal R, Athwal GS, MacDermid JC, Faber KJ, Drosdowech DS, El-Hawary R, et al. Single versus double-incision technique for the repair of acute distal biceps tendon ruptures: a randomized clinical trial. *J Bone Joint Surg Am* 2012;94:1166-74. <http://dx.doi.org/10.2106/JBJS.K.00436>
- Hallam P, Bain GI. Repair of chronic distal biceps tendon ruptures using autologous hamstring graft and the Endobutton. *J Shoulder Elbow Surg* 2004;13:648-51. <http://dx.doi.org/10.1016/j.jse.2004.01.032>
- Hamer MJ, Caputo AE. Operative treatment of chronic distal biceps tendon ruptures. *Sports Med Arthrosc* 2008;16:143-7. <http://dx.doi.org/10.1097/JSA.0b013e3181824e76>
- Hinchey JW, Aronowitz JG, Sanchez-Sotelo J, Morrey BF. Re-rupture rate of primarily repaired distal biceps tendon injuries. *J Shoulder Elbow Surg* 2014;23:850-4. <http://dx.doi.org/10.1016/j.jse.2014.02.006>
- Jockel CR, Mulieri PJ, Belsky MR, Leslie BM. Distal biceps tendon tears in women. *J Shoulder Elbow Surg* 2010;19:645-50. <http://dx.doi.org/10.1016/j.jse.2010.01.015>
- John CK, Field LD, Weiss KS, Savoie FH 3rd. Single-incision repair of acute distal biceps ruptures by use of suture anchors. *J Shoulder Elbow Surg* 2007;16:78-83. <http://dx.doi.org/10.1016/j.jse.2006.03.002>
- Johnson TS, Johnson DC, Shindle MK, Allen AA, Weiland AJ, Cavanaugh J, et al. One- versus two-incision technique for distal biceps tendon repair. *HSS J* 2008;4:117-22. <http://dx.doi.org/10.1007/s11420-008-9085-4>
- Kelly EW, Morrey BF, O'Driscoll SW. Complications of repair of the distal biceps tendon with the modified two-incision technique. *J Bone Joint Surg Am* 2000;82-A:1575-81.
- McKee MD, Hirji R, Schemitsch EH, Wild LM, Waddell JP. Patient-oriented functional outcome after repair of distal biceps tendon ruptures using a single-incision technique. *J Shoulder Elbow Surg* 2005;14:302-6. <http://dx.doi.org/10.1016/j.jse.2004.09.007>
- Morrison KD, Hunt TR. Comparing and contrasting methods for tenodesis of the ruptured distal biceps tendon. *Hand Clin* 2002;18:169-78.
- Rantanen J, Orava S. Rupture of the distal biceps tendon. A report of 19 patients treated with anatomic reinsertion, and a meta-analysis of 147 cases found in the literature. *Am J Sports Med* 1999;27:128-32.
- Safran MR, Graham SM. Distal biceps tendon ruptures: incidence, demographics, and the effect of smoking. *Clin Orthop Relat Res* 2002;275-83.
- Sanchez-Sotelo J, Morrey BF, Adams RA, O'Driscoll SW. Reconstruction of chronic ruptures of the distal biceps tendon with use of an Achilles tendon allograft. *J Bone Joint Surg Am* 2002;84-A:999-1005.
- Seiler JG, Parker LM, Chamberland PD, Sherbourne GM, Carpenter WA. The distal biceps tendon. Two potential mechanisms involved in its rupture: arterial supply and mechanical impingement. *J Shoulder Elbow Surg* 1995;4:149-56.
- Snir N, Hamula M, Wolfson T, Meislin R, Strauss EJ, Jazrawi LM. Clinical outcomes after chronic distal biceps reconstruction with allografts. *Am J Sports Med* 2013;41:2288-95. <http://dx.doi.org/10.1177/0363546513502306>
- Vastamäki M, Vastamäki H. A simple grafting method to repair irreparable distal biceps tendon. *Clin Orthop Relat Res* 2008;466:2475-81. <http://dx.doi.org/10.1007/s11999-008-0389-y>
- Wiley WB, Noble JS, Dulaney TD, Bell RH, Noble DD. Late reconstruction of chronic distal biceps tendon ruptures with a semitendinosus autograft technique. *J Shoulder Elbow Surg* 2006;15:440-4. <http://dx.doi.org/10.1016/j.jse.2005.08.018>