

Patients Have Strong Preferences and Perceptions for Biceps Tenotomy Versus Tenodesis



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Purpose: To evaluate what factors are important in the patients' preference and their perception of a successful surgical outcome. **Methods:** A biceps-specific questionnaire was developed using a series of questions assessing current symptoms, previous knowledge of biceps tendon surgery, surgical outcome priorities, and patient demographics and administered to 100 patients with proximal biceps pathology after approval by the Institutional Review Board. The patients were asked which surgery they would prefer. A set of χ^2 tests were used to test the association between categorical variables. All tests were 2-sided and considered significant at $P < .05$. **Results:** A total of 100 patients enrolled in the study, with 49 female and 51 male patients at an average age of 49 years (range, 19 to 79 years). Of the 100 patients, 64 (64%) chose to have biceps tenodesis. Factors predictive of choosing a biceps tenodesis included female sex, and concern of cosmetic deformity and residual postoperative pain with a tenotomy ($P < .05$). Factors predictive of choosing a tenotomy included male sex, high level of current bicipital groove pain, and concerns regarding the use of additional hardware and longer recovery with a tenodesis ($P < .05$). Age, body mass index, occupation, income level, and concerns regarding postoperative strength and muscle cramping were not found to have a significant predictive effect toward either procedure. **Conclusions:** Patient age should not be used as the sole criterion when deciding between biceps tenotomy and tenodesis. Our results can be consolidated to 5 predictive, reliable questions that will assist orthopaedic surgeons in making individualized patient-specific decisions regarding proximal biceps tendon surgery by emphasizing what factors are most important to patients for a successful surgical outcome.

Biceps tendon pathology is a common contributor to anterior shoulder pain, either in isolation or in association with glenoid labrum and rotator cuff pathology. Although most patients achieve pain relief and restoration of baseline function with nonoperative

modalities consisting of nonsteroidal anti-inflammatory medications, physical therapy, and corticosteroid injections,¹ a subset of patients will require surgical intervention. The 2 surgical interventions for biceps tendon pathology are biceps tenotomy and tenodesis. The decision to perform either a tenotomy or tenodesis is made at the discretion of the treating surgeon, as there is little data to support a clearly defined treatment protocol for injuries to this tendon.²⁻⁴ Both procedures have been shown to provide equivalent functional outcomes, and to date, there is no consensus on the superiority of either procedure.⁵⁻⁷

There is no clear consensus showing superior long-term functional outcomes with either biceps tenotomy or tenodesis that may be explained by the absence of high-level comparative research. However, there are well-defined short-term advantages and disadvantages of both procedures. Proponents of biceps tenotomy advocate that there is no additional hardware required, and because tendon to bone healing is not necessary, the postoperative rehabilitation is shorter and less painful. However, it is well established that tenotomy

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does carry the risk of a cosmetic deformity known as a “Popeye” deformity, and patients may complain of postoperative biceps muscle cramping.^{5,6,8} Although biceps tenodesis is a more technically complex procedure, advocates accept the use of additional hardware and a longer rehabilitation time, with the advantages of improved cosmesis and the decreased incidence of postoperative muscle cramping. However, biceps tenodesis does have associated complications such as postoperative proximal humerus fractures⁹ and neurologic injuries.¹⁰

A recent systematic review by Slenker et al.⁴ showed that the only significant difference between the 2 procedures was the increased incidence of a “Popeye” deformity with a tenotomy. At the present time, we believe the decision to undergo a given procedure is generally mediated by surgeon preference. A commonly held view suggests that patients younger than 55 years should undergo a tenodesis because they tend to be more active, with tenotomy being reserved for patients aged 55 years and older because they are on average more sedentary.^{4,11} However, this dichotomy fails to take into account the individual patient physical activity level, tolerance of postoperative restrictions, and cosmetic concerns.

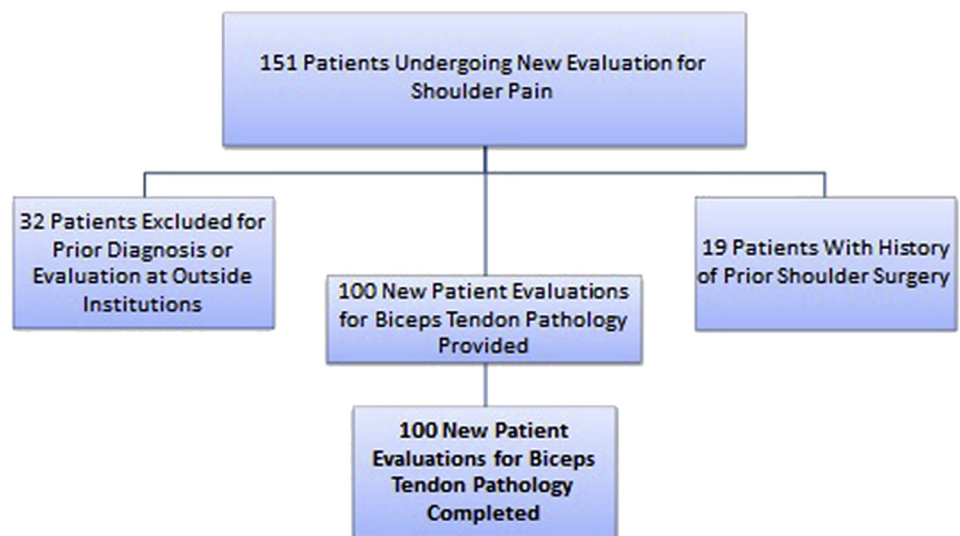
As the orthopaedic community continues to debate the optimal treatment for biceps tendon pathology, patient perceptions and expectations of the 2 surgical interventions have not been previously described. The purpose of this study was to evaluate what factors are important in the patients’ decision making and their perception of a successful surgical outcome in proximal biceps tendon surgery. The hypothesis of this study was that age would not be a significant factor in terms of surgical decision making when choosing between biceps tenotomy and tenodesis.

Methods

This is a prospective cross-sectional survey study designed to determine the factors that are most important in patient decision making when choosing between 2 standard surgical interventions for biceps tendon pathology. The study was approved by the Institutional Review Board. A proximal biceps tendon-specific questionnaire was developed by a group of attending orthopaedic surgeons who currently practice in an urban academic medical center. Each question was designed to obtain potentially predictive demographic data and/or consider a potentially pertinent patient concern; question design and content was guided by physician experience. The initial study population consisted of 100 patients presenting to one of our urban academic medical center clinics over a 6-month period from January 1, 2014, to June 30, 2016. The inclusion criterion was any patient 18 years of age or older who at his and/or her initial office visit was clinically diagnosed with long head of the biceps tendonitis by 1 of 4 attending surgeons (C.S.A., W.N.L., C.M.J., C.A.P.). Exclusion criteria included any patient who had a known prior diagnosis of biceps tendonitis or had a history of prior shoulder surgery in either extremity. This was done to minimize the risk of bias by previous conversations with orthopaedic surgeons (Fig 1).

During the office visit, it was explained that the most patients with proximal biceps tendonitis can successfully be treated with nonoperative modalities. However, surgical intervention may be required for a subset of patients who fail nonoperative management. The 2 surgical options, biceps tenotomy and tenodesis, were introduced by the attending surgeon to the patients using a simple description of both procedures that was consistent with the questionnaire. An unvalidated questionnaire was then administered by a medical

Fig 1. Flowchart of subject enrollment.



Biceps Surgery Options

1) TENOTOMY – the biceps tendon is cut from within your shoulder and NOT reattached. There is no hardware used. The biceps muscle sometimes develops a “popeye” appearance. Rehabilitation is shorter than with tenodesis. Strength, pain relief, and function are usually reliably good.

2) TENODESIS – the biceps tendon is cut from within your shoulder and then reattached to your arm bone using hardware. The biceps muscle rarely develops a “popeye” appearance. Rehabilitation is longer than with tenotomy and with temporary lifting restrictions. Strength, pain relief, cosmetic appearance, and function are usually reliably good.

Comparative studies show both Tenotomy and Tenodesis have similar functional outcome, pain relief, arm and shoulder strength, and motion.

	TENOTOMY	TENODESIS
Pain Relief	Similar	Similar
Rehabilitation Time	Likely Shorter	Likely Longer
Arm Strength	Similar	Similar
Arm Range of Motion	Similar	Similar
Biceps “Popeye” Appearance	More Likely	Less Likely
Tendon Fixation Hardware	None	Yes
Temporary Biceps Cramping	More Likely	Less Likely

Fig 2. The first page of the questionnaire was an informative page describing the 2 procedures along with a picture of a right-sided “Popeye” deformity.

Biceps “Popeye” Appearance (arrow)



student, at which time the patient could evaluate the advantages and disadvantages of both procedures (Fig 2). After the questionnaire was completed by the patient, the treating surgeon continued the office visit per standard of care, answering any remaining questions in accordance to his current standards of practice.

The first page of the questionnaire was an informative page describing the 2 procedures along with a picture of a “Popeye” deformity (Fig 2). The informative page was followed by a series of 38 questions. The first series of questions (1 to 9) inquired about the patients’ current symptoms, including the present appearance of their biceps muscle as well as their level of pain over the bicipital groove, lateral shoulder, acromioclavicular joint, and biceps muscle as delin-

eated on a photograph. The patients were also asked to rate the strength of their shoulder when lifting items over their head, the strength of their elbow when bending their arm, and their strength of forearm rotation when turning a screwdriver or doorknob. The next series of questions (10 to 25) asked about postoperative patient expectations, specifically looking to identify what outcomes would be perceived as a successful surgery. Questions included the importance of postoperative pain relief, strength of the arm, appearance of the biceps, and length of rehabilitation, along with the level of concern regarding the use of additional hardware in a tenodesis. The patients were also asked if they would consider revision surgery or pursue litigation for continued pain or “Popeye” deformity

Columbia University
Center for Shoulder Elbow and Sports Medicine

Name: _____
 Date: _____

Perceptions of Biceps Tendon Surgery Questionnaire

- Consider these marked * locations for pain

- Circle the number that best represents your answer



1. How much pain do you have at the * mark?
 0 1 2 3 4 5 6 7 8 9 10
 No pain Extreme pain

2. How much pain do you have at the * mark?
 0 1 2 3 4 5 6 7 8 9 10
 No pain Extreme pain

3. How much pain do you have at the * mark?
 0 1 2 3 4 5 6 7 8 9 10
 No pain Extreme pain

4. How much pain do you have at the * mark?
 0 1 2 3 4 5 6 7 8 9 10
 No pain Extreme pain

5. How much shoulder strength do you have when lifting things over your head?
 0 1 2 3 4 5 6 7 8 9 10
 No strength Normal Strength

6. How much elbow strength do you have when flexing your arm?
 0 1 2 3 4 5 6 7 8 9 10
 No strength Normal Strength

7. How much forearm rotation strength do you have when turning a screwdriver or doorknob?
 0 1 2 3 4 5 6 7 8 9 10
 No strength Normal Strength

8. Have you ever experienced biceps muscle cramping?
☐ Yes ☐ No

9. How normal is the appearance of your biceps?
 0 1 2 3 4 5 6 7 8 9 10
 Normal Extremely Abnormal

10. How important to you is pain relief after you have fully recovered from surgery?
 0 1 2 3 4 5 6 7 8 9 10
 Not Important Extremely Important

11. How important to you is the strength of your arm after you have fully recovered from surgery?
 0 1 2 3 4 5 6 7 8 9 10
 Not Important Extremely Important

12. How important to you is the appearance of your biceps after surgery?
 0 1 2 3 4 5 6 7 8 9 10
 Not Important Extremely Important

13. Do you feel comfortable with your understanding of biceps tendon surgery?
 0 1 2 3 4 5 6 7 8 9 10
 Poor Understanding Complete Understanding

14. Do you feel comfortable with your understanding of the risks and benefits of biceps tendon surgery?
 0 1 2 3 4 5 6 7 8 9 10
 Poor Understanding Complete Understanding

15. Do you want to learn more regarding biceps surgery?
 0 1 2 3 4 5 6 7 8 9 10
 No

Please Consider the Factors that are Important to You Regarding Your Biceps Surgery

16. How concerned are you that cutting the biceps tendon (Tenotomy) may cause arm weakness despite studies showing similar strength to reattaching the cut tendon (Tenodesis)?
 0 1 2 3 4 5 6 7 8 9 10
 Not Concerned Extremely Concerned

17. How concerned are you that a Tenotomy may cause a biceps "pop-eye" appearance?
 0 1 2 3 4 5 6 7 8 9 10
 Not Concerned Extremely Concerned

18. How concerned are you that a Tenodesis may require longer rehabilitation?
 0 1 2 3 4 5 6 7 8 9 10
 Not Concerned Extremely Concerned

19. How concerned are you that a Tenodesis requires hardware?
 0 1 2 3 4 5 6 7 8 9 10
 Not Concerned Extremely Concerned

20. If pain persists after surgery, how likely are you to undergo repeat surgery for continued pain?
 0 1 2 3 4 5 6 7 8 9 10
 Not Likely Extremely Likely

21. If pain persists after surgery, how likely are you to pursue litigation against your surgeon?
 0 1 2 3 4 5 6 7 8 9 10
 Not Likely Extremely Likely

22. How likely would you undergo repeat surgery for a biceps "pop-eye" appearance?
 0 1 2 3 4 5 6 7 8 9 10
 Not Likely Extremely Likely

23. How likely would you pursue litigation against your surgeon for a biceps "pop-eye" appearance?
 0 1 2 3 4 5 6 7 8 9 10
 Not Likely Extremely Likely

24. Based on the information above, which procedure would you rather have?
☐ Tenotomy
☐ Tenodesis

25. Please describe your major concerns regarding your biceps tendon surgery:

26. What is your occupation?
 (Check the best one)
☐ Laborer Heavy
☐ Laborer Light
☐ Desk Work
☐ Homemaker
☐ Athlete
☐ Disabled/Retired

27. Which sports do you participate in?
 (Check all that apply)
☐ None
☐ Yoga/Pilates
☐ Running/Jogging
☐ Swimming
☐ Cycling
☐ Throwing Sports
☐ Weight Lifting
☐ Racquet Sports
☐ Golf
☐ Contact Sports

28. How often do you play sports?
☐ 0-4 hours/week
☐ 5-9 hours/week
☐ 10-14 hours/week
☐ 15 or more hours/week

29. What is your highest level of education?
☐ Grade School
☐ Some High School
☐ High School Graduate/GED
☐ Vocational/Technical school
☐ Some College
☐ College Graduate
☐ Post Graduate

30. What is your age?

31. What is your sex?
☐ Male ☐ Female

32. What is your weight?
 _____ lbs

33. What is your height?
 _____ feet, _____ inches

34. Which is your dominant arm?
☐ Right ☐ Left

35. Which arm is being evaluated for Biceps surgery?
☐ Right ☐ Left

36. What is your income level?
☐ <\$50k/year
☐ \$50-100k/year
☐ \$100-250k/year
☐ \$250-500k/year
☐ >\$500k/year

37. Is your Injury a workers compensation claim?
☐ Yes ☐ No

38. Do you receive any state funding? (Medicaid, Welfare, etc.)
☐ Yes ☐ No

Fig 3. The 38-page questionnaire administered to patients.

postoperatively. The patients were then asked, that based on the information provided to them, if they were to ever require surgical intervention, which procedure they would rather have, tenotomy or tenodesis. The final series of questions (26 to 38) gathered personal health data and demographic information including age, sex, height, weight, arm dominance, level of athletic activity, occupation, highest level of education obtained, income level, workers' compensation status, and whether they receive any state funding (Medicaid, welfare, etc.) (Fig 3).

A power analysis was performed, which revealed that 100 patients were required for enrollment to reach 80% power at the 5% significance level. Variables were considered significant at an alpha level of 0.05. Items were compared and descriptive statistics were calculated using SAS software. A set of χ^2 tests were used to test the association between categorical variables and patient groups. All tests were 2-sided and considered significant at $P < .05$.

Results

A total of 100 consecutive patients were included in the study, with 49 female patients and 51 male patients, at an average age of 49 years (range, 19 to 79 years). Characteristics of the study population are reported in Table 1. Of the 100 patients, 64 (64%) preferred to have biceps tenodesis over tenotomy.

Logistic regression results are reported in Table 2. Factors predictive of choosing a tenodesis included female sex ($P = .042$), concerns regarding cosmetic deformity with a tenotomy ($P = .006$), and concern that a tenotomy would lead to residual postoperative pain. Factors predictive of choosing a tenotomy included male sex ($P = .042$), higher level of bicipital groove pain at the present ($P = .036$), concerns regarding the use of additional hardware with a tenodesis ($P = .003$), and concerns regarding a longer recovery time with a tenodesis ($P = .001$). Factors not predictive of choosing either procedure included age ($P = .812$), body mass index ($P = .125$), concern of postoperative muscle

Table 1. Demographic Data for Study Population

Parameter	Data
Age group, %	
55 years or older	40
Younger than 55 years	60
Sex, %	
Male	49
Female	51
Work, %	
Labor light/heavy	15
Nonmanual labor	85
Education status, %	
Completed college degree or greater	74
Do not hold bachelor's degree	26
Average body mass index	26.6

cramping ($P = .689$), importance of postoperative strength ($P = .617$), concern of postoperative weakness with a tenotomy ($P = .223$), occupation ($P = .848$), and income level ($P = .21$).

Discussion

The current study reveals that specific patient characteristics predict a preference between biceps tenotomy and tenodesis. A systematic review published by Slenker et al.⁴ represents the most recent attempt to consolidate these studies into a higher powered investigation. This review shows that across all studies, more than 70% of patients respond favorably to either a tenotomy or tenodesis. However, "Popeye" deformity was present in only 8% of those patients who underwent tenodesis versus 43% in tenotomized patients. A more recent prospective study by Zhang et al.¹² confirms the results of this systematic review, with most patients achieving satisfaction after recovery from either surgery and a higher rate of "Popeye" deformity in the tenotomy group. However, they note that in their patient population, patients who judged the surgical outcome as "fair" or "poor" were most concerned about the long and boring rehabilitation procedure. Of note, Zhang et al.'s study revealed a relatively low deformity rate (9%) compared with the reported literary rate. However, in that study, patients were not stratified by coincident pathology. The authors noted that patients were immobilized postoperatively for longer times than may be necessitated by an isolated long head of the biceps lesion, possibly obscuring the results. Despite these shortcomings, Zhang et al.'s study remains the highest-level published work comparing tenotomy versus tenodesis in recent history.

Despite a lack of high-level evidence in the literature, age has become a widely used and accepted guideline in counseling patients toward a given procedure. A recent survey study of orthopaedic surgeons shows that age remains a significant factor in surgical decision making for long head of the biceps tendon pathology among members of the European Society of Sports

Traumatology, Knee Surgery, and Arthroscopy.¹³ Despite minimal evidence, consensus has emerged that tenotomy might be appropriate for patients over the age of 55 years on the basis that tenodesis requires increased surgical time and slower pain relief. However, our data suggest that age is not a significant factor in predicting which procedure patients might prefer. On the basis of our data, we caution against over-reliance on patient age as a factor in deciding between biceps tenotomy and tenodesis in patients with LHBT lesions.

After providing patients with a concise summary of the outcomes data currently available in the literature, there was an overall preference toward biceps tenodesis. In our statistical analysis, we sought to determine factors that were predictive of choosing tenotomy versus tenodesis using binary regression. Age was not a statistically significant variable in predicting which procedure a patient might choose. Given the consensus on using age as a critical factor for surgical decision making, our data suggest that other questions might better take into account patient priorities and aid in the discussion of surgical options. We therefore do not currently recommend using age as a single determining factor.

We found that female sex, level of concern regarding cosmetic deformity, and importance of pain relief are significant predictors of preference toward biceps tenodesis. We hypothesized that female patients might be more inclined toward cosmetic concerns than their

Table 2. Parameters and Outcomes of Logistic Regression

Parameter	Odds Ratio	P Value
Male sex	0.217	.042
Female sex	1	.042
Pain relief important?	1.824	.030
Strength important?	1.166	.617
Appearance important?	1.109	.562
Concerned tenotomy will cause weakness?	1.183	.223
Concerned tenotomy will cause "Popeye" deformity?	1.589	.006
Concerned tenodesis has longer rehabilitation?	0.593	.001
Concerned tenodesis requires hardware?	0.65	.003
Age	1.006	.812
Body mass index	0.88	.125
Bicipital groove pain	0.762	.036
Average strength	0.955	.782

NOTE. Results of the logistic regression analysis. Factors predictive of choosing a tenodesis included female sex ($P = .042$), concerns regarding cosmetic deformity with a tenotomy ($P = .006$), and concern that a tenotomy would lead to residual postoperative pain. Factors predictive of choosing a tenotomy included male sex ($P = .042$), higher level of bicipital groove pain at the present ($P = .036$), concerns regarding the use of additional hardware with a tenodesis ($P = .003$), and concerns regarding a longer recovery time with a tenodesis ($P = .001$).

male counterparts. Factors associated with a preference toward biceps tenotomy were male sex, higher pain scores about the bicipital groove, and stronger concerns regarding recovery time and the use of hardware in tenodesis. Factors not predictive of choosing either procedure included age, body mass index, concern of postoperative muscle cramping, importance of postoperative strength, concern of postoperative weakness with a tenotomy, occupation, and income level.

Recent work by Duff and Campbell¹⁴ reported that although 34% patients in their tenotomy series reported a visible cosmetic deformity, 11% were actually concerned by the appearance. They concluded that biceps tenotomy is well accepted by most patients with good overall results. Some adverse effects occur but appear to be mild and of little concern to patients. The procedure is tolerated in manually active populations. These reported data do not take into account age ranges in terms of cosmetic concerns. Our data include a wider age range and an average participant age 15 years younger than the population in Duff and Campbell's study. In addition, their study was retrospective. Our study attempts to define aspects that will aid in clinical decision making. To this end, we explained the risks and benefits of each procedure to allow patients to better understand future outcomes.

In recent years, there has been a significant increase in using patient-specific parameters to further optimize surgical interventions for orthopaedic patients. Patient-specific preferences must be taken into account to optimize the type of surgical intervention each patient might undergo to maximize his and/or her perception of outcomes. Our findings suggest that the current consensus for using age cutoffs as a simple way to stratify patients into a tenotomy versus tenodesis group may be suboptimal when patient preferences are being considered.

On the basis of the factors shown to be most statistically significant, our results can be consolidated to 5 predictive, reliable questions that may help guide surgical decision making. Consolidating our findings into a simple, 5 question assessments would aid in surgical counseling and decision making for patients. Question 1: How concerned are you about a possible cosmetic deformity? Question 2: How concerned are you about potential residual postoperative pain? Question 3: How severe is the pain today over the front of your shoulder? Question 4: How concerned are you about a potentially longer recovery time? Question 5: How concerned are you about the use of additional hardware? If the patient shows higher levels of concern regarding a potential cosmetic deformity or residual postoperative pain, then he and/or she will likely have better outcomes with a tenodesis. If the patient has high levels of current bicipital groove pain or concerns regarding a longer recovery time or the use of

additional hardware, then a biceps tenotomy may be more appropriate. Furthermore, our results suggest that female patients had a stronger preference for a tenodesis whereas male patients had a stronger preference for a tenotomy. With this information, a patient-specific, individualized treatment plan can be customized to each patient to increase the probability of a successful surgical outcome.

Limitations

This study has several limitations. The first limitation is that the questionnaire that was developed and used had not been previously validated for internal consistency. However, our group did pilot a number of iterations of the questionnaire to assess whether patients across a broad range of socioeconomic and educational levels could consistently interpret each question with accuracy. The second limitation is the lack of generalizability, because the study was performed in a large metropolitan urban center. The results of the study may not be consistent with those of other populations and patient settings. The third limitation is the potential bias that comes along with surgeons discussing the 2 surgical options with patients before administering the questionnaire. The surgeon may have an inherent bias toward 1 procedure that may influence the answer choices on the questionnaire. The fourth limitation is the fact that the questionnaire was administered at the time of initial evaluation to all patients who met inclusion criteria rather than surveying only those patients actually scheduled for surgery. The patients scheduled for surgery may have different ideas regarding possible surgical outcome than those surveyed at the initial evaluation. The final limitation is related to a discussion of differences in recovery time between the 2 procedures. Although the length of recovery differs between tenotomy and tenodesis, given the high level of coincident shoulder pathology necessitating corresponding surgical intervention, recovery times might be more dependent on the additional procedures rather than the biceps tendon. Given that concerns about longer rehabilitation were significantly associated with a preference for biceps tenotomy, it is possible that patients might have even stronger preferences toward tenodesis.

Conclusions

Patient age should not be used as the sole criterion when deciding between biceps tenotomy and tenodesis. Our results can be consolidated to 5 predictive, reliable questions that will assist orthopaedic surgeons in making individualized patient-specific decisions regarding proximal biceps tendon surgery by emphasizing what factors are most important to patients for a successful surgical outcome.

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