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Comparative outcomes of biceps tenotomy and tenodesis in the treatment of long head of biceps tendon lesions

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Abstract

The debate over the effectiveness of biceps tenotomy versus tenodesis in the management of long head of the biceps brachii (LHB) tendon lesions remains ongoing. This study aims to compare the clinical outcomes and patient satisfaction of these two procedures. Sixty-one patients (16 males and 45 females) were included in the study. Biceps tenodesis was performed on 32 patients, while biceps tenotomy was performed on 29. Statistical analyses were carried out using Statistical Package for the Social Sciences (SPSS) version 29.0, with descriptive statistics, repeated measures analysis of variance (ANOVA), Chi-Square tests, and independent t-tests utilized to compare the outcomes between the groups over a 12-month period. Patients who underwent tenotomy were generally older than those who had tenodesis (p=0.003). There were no significant differences between the groups in terms of body mass index (BMI), follow-up duration, or dominant hand distribution. Both groups demonstrated significant improvements in Visual Analog Scale (VAS), Constant, American Shoulder and Elbow Surgeons Scores (ASES), and range of motion (ROM) over time. However, the tenotomy patients had a higher incidence of cosmetic deformity (Popeye sign) and experienced earlier pain relief. Biceps tenodesis provides superior cosmetic outcomes but requires a longer recovery period. Biceps tenotomy offers faster pain relief but carries a higher risk of cosmetic deformity. The choice between the two procedures should be tailored to the patient's specific factors and preferences.

Keywords: Biceps, tendon, tenotomy, tenodesis, shoulder

Introduction

Pathology involving the proximal long head of the biceps brachii tendon (LHBBT) may occur in isolation but is frequently associated with other shoulder conditions, such as impingement and rotator cuff tears [1]. Various pathological issues, including tendonitis, partial tears, and subluxation, may affect this tendon. although the specific function of the long head of biceps (LHB) in glenohumeral biomechanics remains somewhat unclear, it is well-recognized that LHB can be a source of pain and is vulnerable to injury, particularly in the context of impingement and rotator cuff tear [2-7].

While multiple treatment options have proven effective for LHBT lesions during rotator cuff repairs [8,9], a consensus on the best approach has yet to be established. Biceps tenotomy is an established procedure known for its effectiveness, being relatively simple and time-efficient, and it is observed that significantly alleviate pain [10,11]. However, concerns about potential complications such as cramping, Popeye deformity, and loss of strength because of the tendon migrating distally remain prevalent. As a result, some authors advocate for biceps tenodesis, as it maintains the biceps' normal tension and strength, making it a preferred option for younger patients or those engaged in heavy lifting [8,12].

Several case series have compared the outcomes of biceps tenotomy and tenodesis, suggesting that both are viable options for managing biceps tendon lesions [13,14]. However, findings related to specific aspects of each procedure vary. For instance, regarding the risk of cosmetic deformity, some studies report a significant difference in the incidence of the Popeye sign [14,15], while others indicate no significant difference [16]. Additionally,

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systematic reviews and comparative studies show a notable tendency for patients undergoing biceps tenotomy to develop a Popeye deformity, though many patients tolerate this well [13,17,18]. It's also worth noting that not all patients who undergo biceps tenotomy experience cosmetic deformity, indicating that in some cases, the tendon may become lodged in the bicipital groove after being severed, instead of retracting down the arm.

Since there are no clear evidence-based guidelines favoring one technique over the other, the decision between biceps tenotomy and tenodesis is often based on the surgeon's experience, preference, and patient-specific factors. This study focuses on patient-centered outcomes, aiming to compare both procedures performed. The primary goal is to assess patient satisfaction, potential complications associated with each technique, and to evaluate the impact of age and gender on these outcomes. We hypothesized that overall patient satisfaction would be comparable between the two procedures, with no significant influence of age or gender on the outcomes.

Material and Methods

Study Design and Population

This retrospective study included 61 patients (16 males and 45 females) who underwent arthroscopic rotator cuff repair surgery for LHB tendon lesions between January 2018 and December 2022. The patients were divided into two groups: 32 underwent biceps tenotomy, and 29 underwent biceps tenodesis. Inclusion criteria consisted of adult patients with symptomatic LHB tendon lesions that were unresponsive to conservative treatments, such as anti-inflammatory medications and physical therapy. Exclusion criteria included previous shoulder surgeries, severe concurrent rotator cuff tears, and systemic conditions affecting healing, such as diabetes or rheumatoid arthritis.

The study protocol was conducted according to the Declaration of Helsinki and approved by the local ethical committee of our hospital (Decision no: 338, Date: January 01, 2023).

The decision was based on patient-specific factors, such as age, activity level, and intraoperative findings. Additionally, surgeon preference played a role in cases where both procedures were viable. Surgeries were performed by the same surgeon.

The average age of the tenotomy patients was significantly higher compared to the tenodesis patients ($p<0.001$). There were no significant differences between the groups in terms of gender distribution, dominant hand, or operated side, ensuring a homogeneous study population (Table 1).

Surgical Techniques

Tenotomy procedure

Biceps tenotomy surgery was performed with the patient in the beach chair position under general anesthesia. An arthroscope was inserted through a standard posterior portal to visualize the glenohumeral joint. The LHB tendon was identified and released at its origin from the superior labrum using an arthroscopic biter or a thermal device. The tendon was allowed to retract into the bicipital groove naturally. This technique minimizes the risk of residual tendon stumps and associated irritation.

Tenodesis procedure

Biceps tenodesis involved reattaching the LHB tendon to the humerus using either a subpectoral or suprapectoral approach, based on the surgeon's preference and the patient's anatomy. The patient was positioned in the beach chair position under general anesthesia. The surgical area was prepped and draped in a sterile manner. A 3-4 cm incision was performed below the inferior border of the pectoralis major muscle. Blunt dissection was used to expose the bicipital groove while taking care to protect surrounding neurovascular structures.

The LHB tendon was located, dissected, and freed from its synovial sheath. The tendon was then extracted from the bicipital groove and trimmed to remove any frayed or damaged tissue. A bone socket was drilled in the bicipital groove, sized to match the tendon diameter and the selected fixation device. The prepared LHB tendon was inserted into the bone socket and secured with an interference screw or suture anchor. The fixation device ensured the tendon was securely anchored in the bone socket. The stability of the fixation was confirmed by moving the arm through a full range of motion.

Postoperative rehabilitation

Postoperative care included a structured rehabilitation protocol for both groups. Tenotomy patients were allowed immediate passive and active range of motion exercises, with restrictions on heavy lifting and strenuous activities for the first four weeks. Tenodesis patients followed a similar regimen but with a longer period of restricted activity to allow for tendon healing and secure attachment. Follow-up evaluations were conducted at 3, 6, and 12 months after surgery, assessing pain levels, shoulder function, and patient satisfaction.

Statistic

Statistical analyses were conducted using SPSS version 29.0 (IBM Statistical Package for the Social Sciences (SPSS) Statistics for Windows, Version 29.0, Armonk, NY, USA). The normality of the data was checked using the Kolmogorov-Smirnov and Shapiro-Wilk tests, as well as through skewness and kurtosis evaluation Levene's test was used to examine the homogeneity of variances. Descriptive statistics were presented as mean±standard deviation, median (Min-Max), or n (%), depending on the variable type and the fulfillment of statistical assumptions. Changes in variables over time (Pre, Post, 3rd month, 6th month, and 12th month) were analyzed using Repeated Measures Analysis of Variance (ANOVA). Mauchly's Test of Sphericity was applied to confirm the assumption of sphericity before performing Repeated Measures ANOVA. When significant differences were identified, post hoc comparisons were performed using the Bonferroni multiple comparison test.For categorical variables, the Chi-Square test, Continuity Correction, Fisher's Exact Test, or Fisher-Freeman-Halton Exact Test were utilized, depending on the

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number of categories and expected values. The Mann-Whitney U test was used to analyze continuous variables, the Friedman test, or the independent t-test, depending on whether assumptions were satisfied. When the Friedman test showed significant differences among groups, pairwise comparisons were carried out using the Wilcoxon Signed Rank Test to pinpoint the group responsible for the difference.

Results

Demographic and Clinical Characteristics

The demographic and clinical characteristics of the patients, as presented in Table 1, showed no significant differences between the groups regarding gender, dominant hand, or operated side distribution.

Table 1. Demographic and clinical characteristics of the patients

Variables	Total (n=61)	Tenodesis (n=29)	Tenotomy (n=32)	p
Gender, n (%)				
Male	16 (26.2)	8 (27.6)	8 (25.0)	1.000[a]
Female	45 (73.8)	21 (72.4)	24 (75.0)	
Dominant hand, n (%)				
Left	4 (6.6)	2 (6.9)	2 (6.3)	1.000[b]
Right	57 (93.4)	27 (93.1)	30 (30 (93.8)	
Operated side (%)				
Right	33 (54.1)	17 (58.6)	16 (50.0)	0.676[a]
Left	28 (45.9)	12 (41.4)	16 (50.0)	
Age, mean±SD	60.46±6.30	58.14±5.22	62.56±6.53	0.003[c]
BMI, mean±SD	27.69±4.72	28.07±5.48	27.36±3.96	0.278[c]
Follow-up duration, mean±SD	27.72±3.55	27.79±3.58	27.66±3.58	0.441[c]

a: Chi-Square (Continuity Correction), b: Fisher Freeman Halton Exact Test, c: Independent t test

Figure 1 illustrates the relationships between gender and the tenotomy and tenodesis patients across three different age groups. According to these results, the relationship between gender and the groups is not statistically significant in any of the age groups (p>0.05).

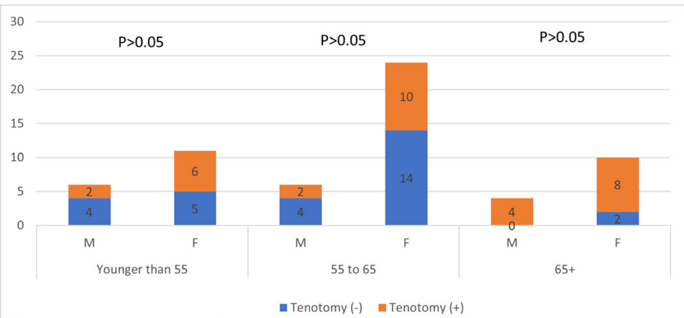

Figure 1. The age and sex distribution of patients undergoing tenotomy and tenodesis showed no statistically significant differences between sexes across the age groups (p>0.05)

VAS Scores: Preoperatively, Visual Analog Scale (VAS) scores were higher than those recorded at 3, 6, and 12 months postoperatively in both the tenodesis and tenotomy patients. Both groups showed statistically significant changes in VAS scores over time (p<0.001). However, within the tenodesis patients, the difference between the 6-month and 12-month VAS scores was not statistically significant (p>0.05). Furthermore, no statistically significant differences were observed between the tenodesis and tenotomy patients in terms of preoperative, 3-month, 6-month, and 12-month VAS scores (p>0.05 for all time points) (Table 2).

Constant Scores: Constant scores significantly improved over time in both groups (p=0.000). There were no statistically significant differences between the tenodesis and tenotomy patients in preoperative, 3-month, 6-month, and 12-month Constant scores (p>0.05 for all time points).

ASES Scores: American Shoulder and Elbow Surgeons Scores (ASES) significantly improved compared to preoperative values (p<0.001). Changes in ASES scores over time were statistically significant in both groups (p<0.001). However, there were no significant differences in preoperative, 3-month, 6-month, and 12-month ASES scores between the tenodesis and tenotomy patients (p>0.05, p>0.05, p>0.05, p>0.05, respectively).

Shoulder abduction, flexion, external rotation, and internal rotation values significantly improved over time in both the tenodesis and tenotomy patients (p<0.001 for all). While changes were significant within each group, no significant differences were found between the groups in preoperative, 3-month, 6-month, and 12-month values for any of these movements (p>0.05 for all time points).

JAMAR Hand Dynamometer Values: Jebsen, Andrus, Mathew, Adams, and Robins (JAMAR) hand dynamometer values showed significant improvement over time in both groups (p<0.001), with no significant differences observed between the groups at postoperative, 6-month, and 12-month follow-ups (p>0.05, p>0.05, p>0.05, respectively).

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Table 2. Comparison of clinical outcomes between tenodesis and tenotomy groups

Variables	Total (n=61)	Tenodesis (n=29)	Tenotomy (n=32)	p
VAS				
Preop	8.0 (5.0-10.0)	8.0 (5.0-10.0)	8.0 (6.0-10.0)	0.671*
3rd month	0.0 (0.0-2.0)	0.0 (0.0-2.0)	0.0 (0.0-2.0)	0.626*
6th month	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.726*
12th month	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.882*
p&	<0.001	<0.001	0.000	
Pairwise comparison between time points within groups£				
p pre-3 mo	<0.001	<0.001	<0.001	
p pre-6 mo	<0.001	<0.001	<0.001	
p pre-12mo	<0.001	<0.001	<0.001	
p 3 mo-6mo	<0.001	<0.001	0.003	
p 3 mo-12 mo	<0.001	<0.001	<0.001	
p 6 mo-12 mo	<0.001	0.083	0.025	
Constant score				
Preop	42.40 (32.40-48.60)	43.40 (32.40-48.60)	42.20 (32.50-47.00)	0.553*
3rd month	74.80 (58.60-88.50)	74.80 (58.60-88.50)	75.30 (59.50-85.70)	0.718*
6th month	80.90 (66.80-90.50)	81.40 (68.60-90.50)	80.75 (66.80-90.20)	0.862*
12th month	88.50 (73.70-93.20)	89.00 (77.80-92.40)	88.35 (73.70-93.20)	0.729*
p&	<0.001	<0.001	<0.001	
Pairwise comparison between time points within groups£				
p pre-3 mo	<0.001	<0.001	<0.001	
p pre-6 mo	<0.001	<0.001	<0.001	
p pre-12mo	<0.001	<0.001	<0.001	
p 3 mo-6mo	<0.001	<0.001	<0.001	
p 3 mo-12 mo	<0.001	<0.001	<0.001	
p 6 mo-12 mo	<0.001	<0.001	<0.001	
ASES score				
Preop	43.42±6.46[a]	43.44±6.32[a]	43.40±6.68[a]	0.983$
3rd month	77.96±6.89[b]	78.25±7.23[b]	77.67±6.66[b]	0.732$
6th month	84.14±5.25[c]	84.02±5.71[c]	84.25±4.89[c]	0.866$
12th month	88.70±3.87[d]	88.98±3.83[d]	88.45±3.95[d]	0.600$
p#	<0.001	<0.001	<0.001	
Shoulder abduction				
Preop	61.52±17.80[a]	61.24±18.02[a]	61.78±17.88[a]	0.907$
3rd month	172.67±4.13[b]	172.34±4.02[b]	172.97±4.27[b]	0.561$
6th month	177.11±2.39[c]	176.23±2.69[c]	177.28±2.11[c]	0.573$
12th month	179.48±1.19[d]	179.28±1.30[d]	179.66±1.06[d]	0.221$
p#	<0.001	<0.001	<0.001	
Shoulder flexion				
Preop	72.0 (46.0-99.0)	72.0 (46.0-99.0)	72.0 (46.0-97.0)	0.784*
3rd month	175.0 (167.0-180.0)	175.0 (167.0-180.0)	175.0 (165.0-180.0)	0.931*
6th month	179.0 (174.0-180.0)	179.0 (174.0-180.0)	179.0 (175.0-180.0)	0.657*
12th month	180.0 (179.0-180.0)	180.0 (179.0-180.0)	180.0 (180-180.0)	0.134*
p&	<0.001	<0.001	<0.001	
Pairwise comparison between time points within groups£				
p pre-3 mo	<0.001	<0.001	<0.001	
p pre-6 mo	<0.001	<0.001	<0.001	
p pre-12mo	<0.001	<0.001	<0.001	
p 3 mo-6mo	<0.001	<0.001	<0.001	
p 3 mo-12 mo	<0.001	<0.001	<0.001	
p 6 mo-12 mo	<0.001	<0.001	<0.001	

*: Mann Whitney U test, &: Friedman Test, £: Wilcoxon test, $: Independent t test, #: repeated measures ANOVA, after repeated measures ANOVA, pairwise period comparisons were made with the Bonferroni multiple comparison test; means with no statistically significant difference in the same column are shown with the same letter (p>0.05)

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Table 2. Comparison of clinical outcomes between tenodesis and tenotomy groups

Variables	Total (n=61)	Tenodesis (n=29)	Tenotomy (n=32)	p
Shoulder external rotation				
Preop	52.0 (29.0-71.0)	53.0 (33.0-71.0)	52.0 (29.0-70.0)	0.729*
3rd month	87.0 (73.0-90.0)	88.0 (75.0-90.0)	87.0 (73.0-90.0)	0.629*
6th month	89.0 (83.0-90.0)	89.0 (83.0-90.0)	89.0 (86.0-90.0)	0.768*
12th month	90.0 (89.0-90.0)	90.0 (89.0-90.0)	90.0 (90.0-90.0)	0.294*
$p^{\&}$	<0.001	<0.001	<0.001	
Pairwise comparison between time points within groups£				
$p^{pre\text{-}3\ mo}$	<0.001	<0.001	<0.001	
$p^{pre\text{-}6\ mo}$	<0.001	<0.001	<0.001	
$p^{pre\text{-}12mo}$	<0.001	<0.001	<0.001	
$p^{3\ mo\text{-}6mo}$	<0.001	<0.001	<0.001	
$p^{3\ mo\text{-}12\ mo}$	<0.001	<0.001	<0.001	
$p^{6\ mo\text{-}12\ mo}$	<0.001	<0.001	<0.001	
Shoulder internal rotation				
Preop	50.0 (29.0-90.0)	50.0 (32.0-90.0)	50.5 (29.0-65.0)	0.696*
3rd month	87.0 (79.0-90.0)	87.0 (79.0-90.0)	86.5 (81.0-90.0)	0.396*
6th month	89.0 (86.0-90.0)	89.0 (87.0-90.0)	89.0 (86.0-90.0)	0.434*
12th month	90.0 (89.0-90.0)	90.0 (89.0-90.0)	90.0 (89.0-90.0)	0.944*
$p^{\&}$	<0.001	<0.001	<0.001	
Pairwise comparison between time points within groups£				
$p^{pre\text{-}3\ mo}$	<0.001	<0.001	<0.001	
$p^{pre\text{-}6\ mo}$	<0.001	<0.001	<0.001	
$p^{pre\text{-}12mo}$	<0.001	<0.001	<0.001	
$p^{3\ mo\text{-}6mo}$	<0.001	<0.001	<0.001	
$p^{3\ mo\text{-}12\ mo}$	<0.001	<0.001	<0.001	
$p^{6\ mo\text{-}12\ mo}$	<0.001	<0.001	<0.001	
Jamar				
postop	40.80 ± 15.18^{a}	40.69 ± 16.14^{a}	40.91 ± 14.51^{a}	$0.956^{\$}$
6th month	54.54 ± 18.85^{b}	54.14 ± 20.12^{b}	54.91 ± 17.94^{b}	$0.875^{\$}$
12th month	56.69 ± 19.93^{c}	56.55 ± 21.68^{c}	56.81 ± 18.56^{c}	$0.960^{\$}$
$p^{\#}$	<0.001	<0.001	<0.001	

*: Mann Whitney U test, &: Friedman Test, £: Wilcoxon test, $: Independent t test, #: repeated measures ANOVA, after repeated measures ANOVA, pairwise period comparisons were made with the Bonferroni multiple comparison test; means with no statistically significant difference in the same column are shown with the same letter (p>0.05)

Discussion

The findings of the present study demonstrate that both biceps tenotomy and tenodesis significantly improve patient outcomes in terms of pain relief, shoulder function, and overall satisfaction. However, notable differences were observed between the two procedures, both tenotomy and tenodesis patients demonstrated significant improvements in VAS scores, Constant, and ASES scores over time, with no statistical difference between the two techniques at 12 months postoperatively. These findings align with previous studies such as MacDonald et al. [19], which also reported comparable functional outcomes between the two procedures, which should be considered when determining the most appropriate treatment for individual patients.

There were no statistically significant differences between tenotomy and tenodesis in terms of clinical scores, total surgical times, and functional outcomes related to the biceps, including arm pain and elbow flexor strength. Consistent with previous studies, such as those by Belay et al. [20]. We compared our results with studies by MacDonald et al. [19] and Belay et al. [20], discussing similarities in patient outcomes and differences in procedural preferences. This contextualizes our findings within the broader body of literature and highlights where our results align with or diverge from previous studies. This early postoperative benefit may make tenotomy a more suitable option for older, low-demand patients.

Duff and Campbell [17] studied patient satisfaction following biceps tenotomy and reported that only 3% of patients expressed concerns about biceps deformity. Similarly, Clement et al. [21] reported no statistically significant differences in deformity between the groups. Notably, a recent retrospective study by Godenèche et al. [22] revealed no occurrence of biceps deformity after either tenodesis or tenotomy during a 10-year follow-up. MacDonald et al. [19] reported a Popeye deformity in 11.4% of patients who underwent tenodesis, which may be attributed to insufficient tensioning of the biceps tendon or performing the tenodesis in a position that allowed excessive slack in the tendon. Hufeland et al. [23] observed a non-significant trend toward a higher incidence of Popeye-sign deformities (27%) after biceps tenotomy compared to tenodesis (11%). In our study, we observed no cases of Popeye deformity in either the biceps tenotomy or tenodesis patients. This finding contrasts with the reported rates in previous studies. We believe that the absence of this complication in our patient cohort may be attributed to precise surgical techniques, particularly with regard to tensioning of the biceps tendon, and the careful selection of patients. These results underscore the potential benefits of a meticulous approach in reducing postoperative complications and enhancing overall patient satisfaction.

Despite the cosmetic disadvantage of tenotomy, this technique consistently showed earlier pain relief compared to tenodesis [20]. Our findings suggest that tenotomy can offer faster postoperative recovery, with patients often reporting less need for pain medication in the early postoperative period compared to those undergoing tenodesis [20]. This early pain relief may be particularly valuable for older, low-demand patients where the cosmetic outcome is less of a concern [21,24].

Tenodesis, on the other hand, is associated with better preservation of muscle strength, particularly in younger, more active patients [22,25]. The avoidance of significant strength deficits in elbow flexion and forearm supination, combined with the lower risk of cosmetic deformities, makes tenodesis a favorable option for younger or more physically active individuals [21,25]. However, this procedure is technically more challenging, resulting in longer operative times and higher costs due to the need for implants [24].

In our study, both tenotomy and tenodesis patients demonstrated significant improvements in VAS, Constant, and ASES scores over time, with no statistical difference between the two techniques at 12 months postoperatively. While tenodesis offers better cosmetic and strength outcomes, it is associated with higher costs due to the need for implants. This factor, along with the longer operative time, should be weighed against the quicker and more affordable tenotomy when deciding the appropriate surgical approach. Our findings suggest that tenotomy may be more suitable for older patients seeking faster recovery with fewer cosmetic concerns, while tenodesis is preferable for younger, active individuals aiming to preserve arm strength and aesthetics.

A limitation of this study is the relatively small number of participants and the brief follow-up duration. To better understand the long-term outcomes and potential complications of both procedures, larger, multi-center studies with extended follow-up durations are required. Additionally, the choice between tenotomy and tenodesis should be tailored to individual patients, taking into account factors such as age, activity level, cosmetic preferences, and the presence of other shoulder pathologies. Future research should also examine the cost-effectiveness of both procedures, factoring in the direct and indirect costs related to surgery, rehabilitation, and any potential complications.

Conclusion

Both biceps tenotomy and tenodesis are effective surgical options for treating LHB tendon lesions, each with distinct advantages. Tenotomy offers faster pain relief and recovery, making it suitable for older patients or those not concerned with cosmetic outcomes. Tenodesis, while requiring a longer recovery period, provides better cosmetic results and is preferable for younger, more active patients. The choice between these procedures should be tailored to the individual patient's needs and preferences, with careful consideration of the benefits and risks associated with each technique. Future research should explore multi-center trials with larger patient cohorts and extended follow-up durations to validate our findings and assess long-term outcomes.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
The study was managed following the Declaration of HELSINKI principles, and Batman Training and Research Hospital ethics committee of approval (Decision no: 338, Date: January 23, 2023) was obtained from the authors' institute.

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