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Massive and irreparable rotator cuff tear treatment by arthroscopic partial repair with long head of the biceps tendon augmentation provides better healing and functional results than partial repair only

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Background: The aim of this study was to compare the clinical and radiologic outcomes of 2 treatment methods for massive and irreparable rotator cuff tears (RCTs): partial repair (PR) and PR with long head of the biceps tendon (LHBT) augmentation. Biceps tendon augmentation is believed to promote better healing at the bone-tendon junction, leading to improved clinical and radiologic outcomes.
Methods: This retrospective comparative study included patients with chronic, massive and irreparable RCTs involving both the supraspinatus (SSP) and infraspinatus muscles. Only patients with failure of nonoperative treatment and at least 1 year of follow-up between 2013 and 2018 were analyzed. The patients were divided into 2 groups based on the chosen treatment method. Irreparability was defined intraoperatively as the inability to achieve sustainable repair of the SSP after complete release, typically corresponding to a Goutallier classification of stage ≥ 3 and Patte classification of stage 3. The clinical assessment protocol involved measurements of range of motion and shoulder strength, as well as the Constant-Murley score (CMS) and Simple Shoulder Test score. Radiologic assessment comprised measurements of the acromiohumeral distance, Hamada classification, Sugaya classification, and Goutallier classification of both the SSP and infraspinatus.
Results: The study included data from 60 patients (30 in each group) with a mean age of 62.5 years and a mean follow-up period of 34.5 months. The retear rate was 43.3% for PR with LHBT augmentation and 73.3% for PR alone ($P = .036$). During the final examination, statistically significant differences in favor of PR with LHBT augmentation were observed for the CMS (76.2 ± 10.9 vs. 70.9 ± 11.5, $P = .034$), Sugaya classification (3.5 ± 1.1 vs. 4.1 ± 0.9, $P = .035$), and acromiohumeral distance (5.8 ± 2 mm vs. 4.7 ± 1.3 mm, $P = .021$). There were no significant differences between the groups in range of motion, shoulder strength, Hamada classification, Simple Shoulder Test score, and postoperative Goutallier stage.

The Poznan University ethical institutional review board approved this study.

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Conclusion: PR with LHBT augmentation for patients with irreparable, massive RCTs provides a lower retear rate and better humeral head centralization, as well as improved results measured by the CMS, compared with PR alone.
Level of evidence: Level III; Retrospective Cohort Comparison; Treatment Study

Keywords: Rotator cuff tear; irreparable, chronic, massive rotator cuff tear; biceps tendon augmentation; partial repair; partial repair with biceps augmentation

Rotator cuff tears (RCTs) are a prevalent pathology that significantly impacts patients' quality of life. As the population continues to age, the number of chronic tears is steadily increasing.[35] Among all RCTs, massive and irreparable cuff tears are known to be especially challenging to manage. Surgery is generally indicated after failure of nonoperative treatment or when an injury results in an acute tear. Over the years, various surgical treatment options have been proposed to improve patients' daily functioning, alleviate pain, and restore shoulder function.[3,20,21] However, the success of arthroscopic repair of the rotator cuff depends on multiple factors, with failure rates as high as 90% for massive lesions.[39]

To enhance the efficacy of surgical treatment, surgeons have explored new methods, including biological[4,16,38] and mechanical[10,28] augmentation, for improving outcomes of massive RCTs. Biological augmentation aims to enhance tissue regeneration and remodeling, whereas mechanical augmentation facilitates tendon healing by reducing tension on repaired tendons.

The concept of long head of the biceps tendon (LHBT) augmentation, initially described as an open procedure by Neviaser[29] and subsequently described as an arthroscopic procedure by Cho et al,[6] combines the advantages of both biological and mechanical augmentation. Moreover, using the autologous LHBT as a graft offers a technique that is easy to implement, is cost-effective, and surpasses other graft options in terms of availability.

Several studies have investigated the effectiveness of LHBT augmentation with comparison to partial repair (PR)[5,6,17,30] for massive or irreparable RCTs.[2] However, the results of these studies have yielded inconsistent results and conclusions. Therefore, the purpose of this study was to compare the clinical and radiologic outcomes of PR with and without LHBT augmentation in patients with massive, irreparable, chronic RCTs. We hypothesized that PR with LHBT augmentation would result in better healing at the bone-tendon junction, leading to improved clinical, functional, and radiologic outcomes.

Materials and methods

In this retrospective comparative study, we evaluated patients with irreparable posterosuperior RCTs who underwent either arthroscopic PR with LHBT augmentation or PR alone. All arthroscopic interventions were preceded by thorough medical examinations and magnetic resonance imaging (MRI) studies. All surgical procedures—PR alone and PR with LHBT augmentation—were performed by 3 experienced surgeons (R.B., A.B., and H.L.) at the same hospital.

Only patients with massive, chronic, irreparable RCTs were included in the study. The inclusion criteria were failure of nonoperative treatment, a minimum 1-year follow-up period, and provision of patient consent for study participation. The exclusion criteria included radiographic evidence of shoulder osteoarthritis, a subscapularis muscle tear greater than type 2 according to the Lafosse classification[23] (tear larger than partial), additional arthroscopic or biological procedures, a symptomatic contralateral shoulder, previous shoulder surgery, or capsulitis. Patients were consented to undergo surgery via either PR alone or PR with LHBT augmentation based on their condition. A summary of RCT inclusion criteria is presented in Table I.

To assess and compare clinical and radiologic outcomes, we divided patients into 2 groups. The study group consisted of patients whose LHBT was determined to be eligible for augmentation based on intraoperative inspection. The control group comprised patients whose LHBT was intraoperatively disqualified from augmentation because of poor tendon quality, dislocation, or lack of LHBT. Only tendons with minimal redness or fraying and stable proximal attachments were used for augmentation. In any case in which the surgeon was irresolute regarding tendon quality, the LHBT was not used for further augmentation. The same author conducted all evaluations using standardized diagnostic imaging equipment.

Outcome measures

Clinical results

Clinical outcomes were assessed through range-of-motion (ROM) measurements, including forward flexion (FF), abduction, and external rotation (ER), with the use of the Meloq EasyAngle goniometer (Stockholm, Sweden), with precision to 1°. Internal rotation was measured according to the method described by Sraj.[33] Measurements of shoulders undergoing surgery and contralateral, uninjured shoulders were performed by the same author.

Shoulder force was examined using the Beslands SF-500 isometric dynamometer, with a precision of 0.1 kg. FF force, abduction force, ER force, and force in the Jobe position[18] were examined for both shoulders. Preoperative and postoperative results were compared between the study

Table I Summary of criteria defining massive, chronic, irreparable rotator cuff tears

Full-thickness tear of ≥2 tendons (Gerber)[13]
Tear diameter > 2 cm on preoperative MRI (Davidson)[9]
Chronic (>6 mo) symptoms of painful shoulder[11]
Fatty infiltration > grade 2 in ≥1 tendon (SSP and/or ISP)[14]
Tendon retraction grade 3 without possibility of repositioning tendon in anatomic position after arthroscopic tendon release[31]
Tear type C or D (Collin)[7]

MRI, magnetic resonance imaging; *SSP*, supraspinatus tendon; *ISP*, infraspinatus tendon.

and control groups. To evaluate shoulder function, preoperative and postoperative assessments were performed using the Constant-Murley score (CMS), Simple Shoulder Test score, and visual analog scale score.[8,24,32]

Radiologic results

Postoperative MRI was performed after at least 1 year of follow-up using the Philips Interna 3-T apparatus (Andover, MA, USA). The repaired rotator cuff's quality and thickness were assessed using the 5-point Sugaya grading scale.[34] Postoperative MRI scans were oriented toward the upper part of the infraspinatus (ISP) in the frontal-sagittal plane and were reviewed by a radiologist specialized in the assessment of the upper girdle of the body.

Postoperative anteroposterior radiographs were obtained after a minimum of 1 year of follow-up to assess the degree of humeral head migration. The Hamada classification,[15] a 5-point scale, was used to assess the acromiohumeral distance (AHD) and shoulder degenerative changes. Two authors independently evaluated the radiographs.

Surgical technique

The surgical procedures were performed with patients in the beach-chair position, under general anesthesia with an interscalene nerve block. The standard posterior ''soft spot'' portal was used, followed by the creation of an additional anterolateral portal. Arthroscopic examination confirmed the presence of a massive RCT. Bursectomy and mobilization of the supraspinatus (SSP) and ISP muscle and tendons were performed using lateral and posterolateral portals. A back-to-front capsulotomy was carried out, and the coracohumeral ligament was released to mobilize the SSP tendon and confirm irreparability. Then, the condition of the LHBT was assessed. In case of any LHBT-related pathology, tenodesis or tenotomy of the LHBT was performed and we continued with a partial reconstruction technique convergent with the technique published by Burkhart et al.[2] Otherwise, the LHBT was used to augment the upper-posterior part of the rotator cuff.

Partial reconstruction with LHBT augmentation

Initially, the aforementioned arthroscopic procedures involved bursectomy and complete rotator cuff release. In cases in which the RCT was irreparable, low tenodesis of the LHBT was performed, provided that the tendon was well preserved.

Optimal visualization of the bicipital groove and proper assessment of the quality of the LHBT were achieved through the lateral viewing portal and anteromedial working portal. Subsequently, after tenodesis, the LHBT was reinforced by circumtying it with sutures (Fig. 1). Next, the suture from the stitches on the LHBT was passed through the deeper layer of the ISP tendon. The critical aspect of this technique was to pass the suture through the firm and durable portion of the ISP tendon (Fig. 2). Care should be taken not to pass the suture too medially because this could increase the tension between the LHBT and ISP, resulting in a higher retear rate and compromised healing. Following this, a 2-layered reconstruction of the ISP was performed using lasso-loop stitches. The proximal attachment of the LHBT was released, and the LHBT was transposed posteriorly to the superior portion of the ISP and firmly tied. If there was any additional mobility of the upper part of the ISP or lower part of the SSP tendon, another anchor was introduced anteriorly. The sutures from the additional implant were passed through either the LHBT lying on the greater tubercle, the ISP, or remnants of the SSP to minimize the gap between the tendons (Fig. 3). Arthroscopic views of the completed reconstruction are presented in Figure 4.

The aforementioned technique is a modification of the LHBT augmentation technique proposed by Cho et al[6] in 2009. In contrast to Cho et al, we decided to perform LHBT augmentation with low LHBT tenodesis to avoid excess tension between the LHBT and the ISP in an effort to yield a lower retear rate (Fig. 5).

Rehabilitation protocol

The postoperative rehabilitation protocol consisted of the use of a simple shoulder-arm sling to alleviate pain for 6 weeks following surgery. During the period of sling use, passive flexion and extension of the elbow joint, as well as passive rotation of the shoulder joint, were performed for 6 weeks. Additionally, isometric deltoid exercises and passive ER according to the level of pain tolerance were introduced 2 weeks after the operation. After 6 weeks, routine radiographic and ultrasound examinations were conducted to assess implant position and exclude any pathology of reconstructed tendons. At this stage, active rotation, flexion, and abduction exercises were introduced. Initially, patients were required to exercise twice a day using a resistance band with a maximum load of 1 kg. The interval for increasing the load was set at 4.5 months after the operation. Patients were permitted to return to work if

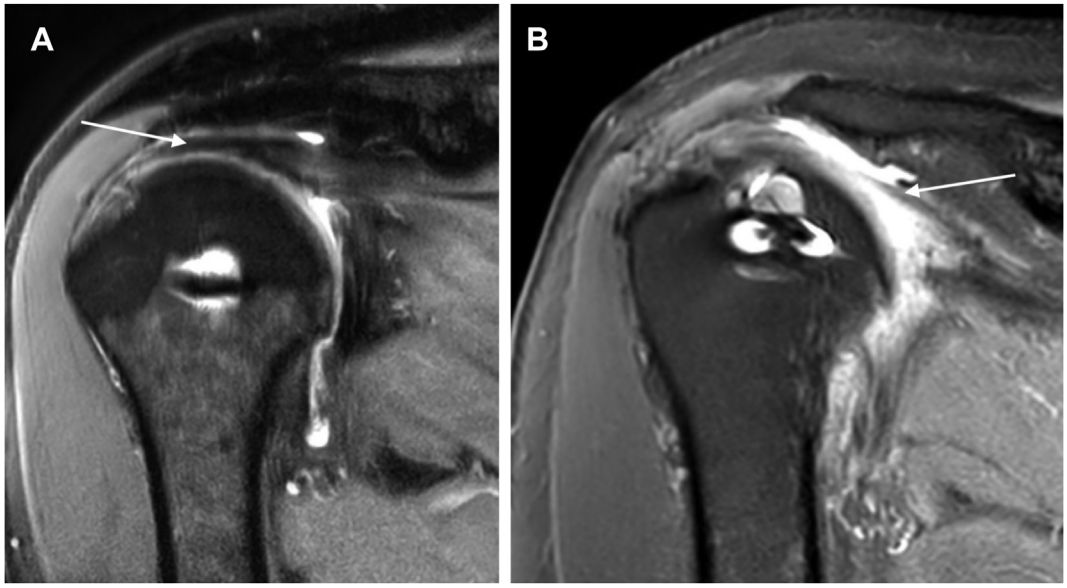

Figure 1 Postoperative magnetic resonance imaging scans used to measure Sugaya scale, showing scores of 2 (**A**) and 5 (**B**). The *arrows* point toward the upper part of the infraspinatus tendon.

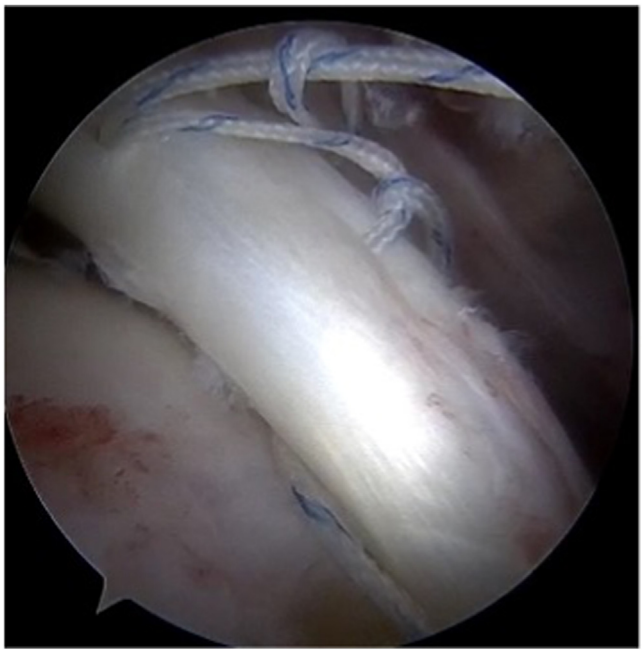

Figure 2 Tenodesis of long head of biceps tendon with additional stitches used for tendon reinforcement.

they experienced no pain and had satisfactory ROM. Shoulder joint assessment was followed by MRI and radiographic imaging at the 1-year follow-up.

Statistical analysis

All data were collected and analyzed using PQStat software (PQStat Software, Plewiska, Poland). The normal distribution of each parameter was tested with the Shapiro-Wilk test and D'Agostino test. The Student *t* test and Mann-Whitney *U* test were used to compare the 2 groups for the normal distribution of variables and to verify our hypothesis. Tests were interchangeably used according to the normal distribution for each parameter in both groups. The Fisher exact test was used to compare qualitative variables between the 2 groups. Pearson and Spearman correlations were used to assess the relationships between variables. The level of statistical significance was set at $P < .05$. All data are presented as mean values and standard deviations.

Results

Initially, 68 patients from a single hospital were included in the study. Despite several attempts to contact them, 7 patients were lost to follow-up. One patient reported exacerbation of pain and a decrease in ROM. Consequently, this patient underwent revision surgery to reverse total shoulder arthroplasty and was excluded from the study.

Finally, a total of 60 patients were enrolled in the study, with 30 in the control group and 30 in the study group. The mean follow-up period for the study group was 30.8 ± 11 months, whereas it was 38 ± 9.9 months for the control group. The difference was not statistically significant ($P = .078$). The overall mean follow-up period for both groups was 34.8 ± 10.2 months. Patient characteristics are presented in Table II.

Functional outcomes

Regardless of the treatment method, both groups showed a statistically significant improvement in ROM in each

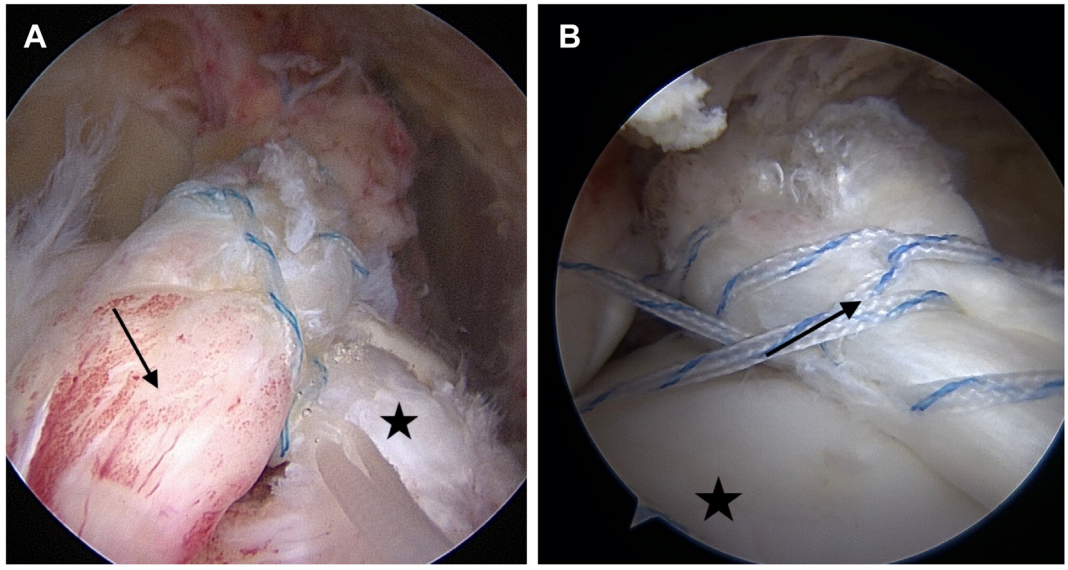

Figure 3 (**A**) Long head of biceps tendon *(→)* transferred posteriorly. (**B**) Long head of biceps tendon (→)–infraspinatus junction. The ★ indicate the greater tubercle of the humerus.

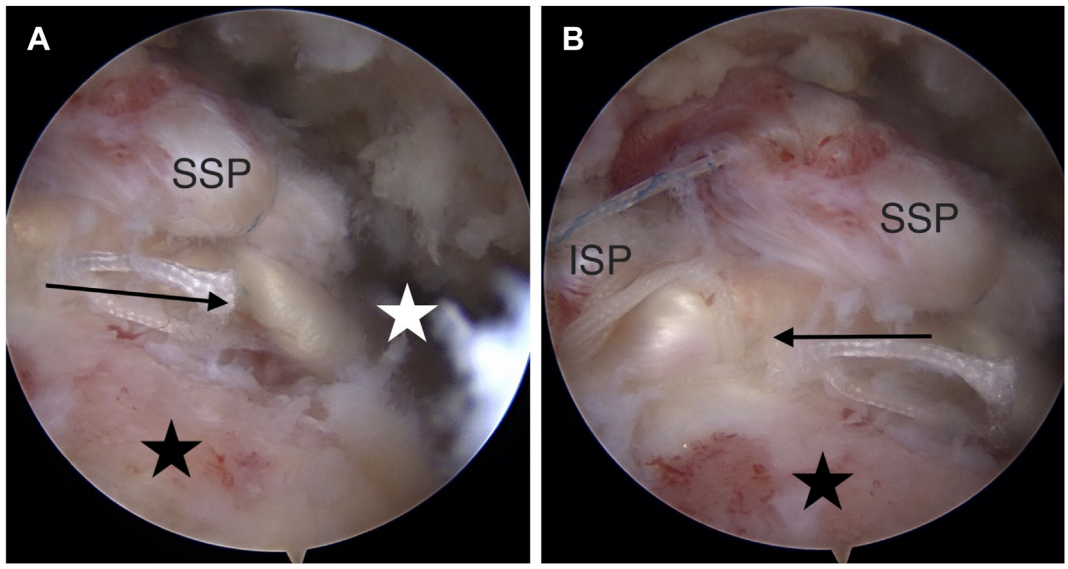

Figure 4 (**A** and **B**) Final views of partial repair with augmentation of long head of biceps tendon (→). The ★ indicate the anatomic footprint of the supraspinatus *(SSP)*. The *white star* encompasses the area that is not covered with rotator cuff tendons. *ISP*, infraspinatus.

measured direction. There were no statistically significant differences in final ROM or the progress between the 2 groups. Similarly, no statistically significant differences in postoperative measurements of strength were found between the groups. The individual force measurements for the study and control groups were as follows: FF force, 6.6 ± 4.5 kg and 6.2 ± 4.8 kg, respectively ($P = .078$); abduction force, 7.8 ± 5.2 kg and 7.7 ± 5.7 kg, respectively ($P = .91$); ER force, 5.3 ± 3.1 kg and 4.5 ± 3 kg, respectively ($P = .363$); force in Jobe position, 5 ± 2.8 kg and 4.5 ± 2.4 kg, respectively ($P = .447$).

The mean CMS values in the study and control groups were 76.2 ± 10.9 and 70.9 ± 11.5, respectively, and the difference was statistically significant ($P = .044$). On the Simple Shoulder Test, the mean score was 73.4 ± 11.7 in the study group and 68.9 ± 14.8 in the control group; however, the difference was not statistically significant ($P = .201$). On the visual analog scale, the mean scores in the study and control groups were 2 ± 1.1 and 2.6 ± 1.3, respectively, and the difference was not statistically significant ($P = .07$). All clinical results are summarized in Tables III and IV.

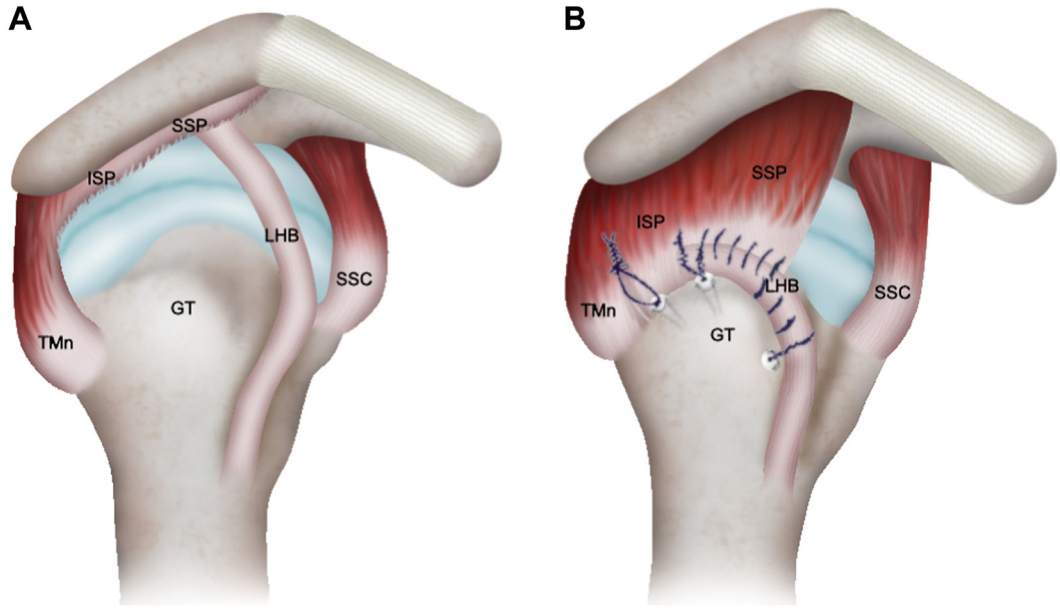

Figure 5 Illustrations of partial repair with long head of biceps LHBT - long head of biceps tendon augmentation. (**A**) Preoperatively. (**B**) Postoperatively. *SSP*, supraspinatus tendon; *ISP*, infraspinatus tendon; *SSC*, subscapularis tendon; *GT*, greater tubercle; *TMn*, teres minor.

Table II Patient characteristics

	Overall (N = 60)	Study group (n = 30)	Control group (n = 30)	*P* value
Mean age, yr	63.8	61.8	65.8	.058
Sex, n (%)				.07
Women	26 (43.3)	10 (33.3)	16 (53.3)	
Men	34 (56.6)	20 (66.6)	14 (46.6)	
Dominant shoulder, n (%)				.171
Yes	41 (68.3)	18 (60)	23 (76.6)	
No	19 (31.6)	12 (40)	7 (23.3)	
Follow-up, mean (SD), mo	34.8 (10.2)	30.8 (11)	38 (9.9)	.078

SD, standard deviation.

Radiologic outcomes

In the study group, tendon healing was observed on postoperative MRI in 17 patients (56.7%), whereas in the control group, it was observed in only 8 patients (26.7%), with a statistically significant difference ($P = .036$). However, none of the patients without healing required a revision procedure during the follow-up period.

On the Sugaya scale, the mean values in the study and control groups were 3.5 ± 1 and 4.1 ± 0.9, respectively, and this difference was statistically significant ($P = .035$). SSP muscle fatty degeneration measured according to the Goutallier classification was, on average, 3.7 ± 1 in the study group and 3.9 ± 0.9 in the control group, but this difference was not statistically significant ($P = .424$). ISP muscle fatty degeneration in the study and control groups measured 2.9 ± 1 and 3.2 ± 1.1, respectively, but this difference was not statistically significant ($P = .293$).

On the Hamada scale, the mean scores in the study and control groups were 2.3 ± 0.8 and 2.7 ± 0.9, respectively, yet the difference was not considered statistically significant ($P = .083$). The mean AHD was 5.9 ± 2 mm in the study group and 4.7 ± 1.3 mm in the control group, and this difference was statistically significant ($P = .021$). During the follow-up period, there were no complications related to the surgical treatment. Total radiologic outcomes are summarized in Table V.

Discussion

The most important finding of this study was that PR with an LHBT augmentation technique provided improved

Table III Functional outcomes: CMS, SST score, and VAS score

	Study group	Control group	*P* value
CMS	76.2 (10.9)	70.9 (11.5)	.034
SST score	73.4 (11.7)	68.9 (14.8)	.201
VAS score	2 (1.1)	2.6 (1.3)	.07

CMS, Constant-Murley score; *SST*, Simple Shoulder Test; *VAS*, visual analog scale.
Data are presented as mean (standard deviation).

Table IV Clinical outcomes: postoperative force measurements and comparisons with contralateral shoulders

	Study group	Control group	*P* value
Forward flexion force			
Postoperative, mean (SD), kg	6.6 (4.5)	6.2 (4.8)	.782
Comparison with contralateral shoulder	75.7%	73.7%	.106 for study group .11 for control group
Abduction force			
Postoperative, mean (SD), kg	7.8 (5.2)	7.7 (5.7)	.908
Comparison with contralateral shoulder	76.9%	76.3%	.126 for study group .11 for control group
External rotation force			
Postoperative, mean (SD), kg	5.3 (3.1)	4.5 (3)	.363
Comparison with contralateral shoulder	80.1%	71.6%	.152 for study group .0475 for control group
Force in Jobe position			
Postoperative, mean (SD), kg	5 (2.8)	4.5 (2.4)	.447
Comparison with contralateral shoulder	74.9%	67.4%	.059 for study group .009 for control group

SD, standard deviation.

clinical and radiologic outcomes with a lower retear rate than PR alone. After a mean follow-up period of 34.8 months, 56.7% of reconstructed RCTs with augmentation were healed compared with only 26.7% in the control group. Another important finding was that patients treated by PR with LHBT augmentation had better centralization of the humeral head postoperatively measured by the AHD. What is more, functional outcomes measured by the CMS were significantly better in the augmentation group.

ROM improvement is of great importance because many patients complain about pain and shoulder movement restriction. This study showed no statistically significant differences in ROM improvement between the study populations. Both arthroscopic interventions are consistent with the outcomes of research by Burkhart et al[1,2] showing that restoration of rotator cable insertions improves shoulder ROM and function. This conclusion was further confirmed by other studies.[12,19,25] However, full coverage of the humeral head was not proved to be pivotal in restoring the biomechanics of the shoulder.[35]

On the other hand, among studies comparing PR vs. PR with LHBT augmentation, Chiang et al[5] observed a statistically significant ROM difference in favor of partial reconstruction with LHBT augmentation in every measured direction after 6 months of reconstruction. Nevertheless, every other study concerning a similar issue showed no advantage of LHBT augmentation over simple PR in any ROM improvement.[6,17,30]

To evaluate force improvement, we compared the operative shoulders with the contralateral shoulders postoperatively. There were no statistically significant differences in force parameters between the groups in the final calculation. The only difference in strength observed during the study was in the control group when we juxtaposed ER strength and Jobe strength with the contralateral, uninjured shoulder ($P = .047$ and $P = .009$, respectively). Therefore, it can be deduced that ER and Jobe position strength of the operative shoulder improved in the study group to such an extent that no statistically significant difference was noted when compared with the healthy shoulder. In other studies that used the LHBT for augmentation during RCT repair, final force measurements were inconclusive. Jeon et al[17] did not observe a statistically significant advantage of LHBT augmentation compared with PR alone. On the other hand, Cho et al[6] demonstrated greater improvements in FF strength, ER strength, and internal rotation strength in

Table V Summary of all radiologic outcomes in study and control groups

	Study group	Control group	*P* value
Radiography			
AHD, mean (SD), mm	5.9 (2)	4.7 (1.3)	.021
Hamada scale, mean (SD)	2.3 (0.8)	2.7 (0.9)	.083
MRI			
Tendon healing, n	17 (56.7%)	8 (26.7%)	.036
Sugaya scale, mean (SD)	3.5 (1)	4.1 (0.9)	.035
TMN diameter, mean (SD), mm	22.9 (4.9)	20.8 (5.4)	.098
SSP fatty degeneration, mean (SD)	3.7 (1)	3.9 (0.9)	.424
ISP fatty degeneration, mean (SD)	2.9 (1)	3.2 (1.1)	.293

AHD, acromiohumeral distance; *MRI*, magnetic resonance imaging; *TMN*, teres minor; *SSP*, supraspinatus tendon; *ISP*, infraspinatus tendon.

patients treated with LHBT augmentation repair compared with non-augmentation repair.

The results of functional scale assessment showed better CMS values for the LHBT augmentation group than the control group: 76.2 ± 10.9 vs. 70.9 ± 11.5 ($P = .044$). However, the clinical significance of this difference is ambiguous. Kukkonen et al[22] estimated the minimal clinically important difference (MCID) in the CMS at 2-16 points depending on the follow-up period, with a mean CMS improvement of 10.4 points 3 months after surgery. On the other hand, Xu et al[36] reported that the MCID in the CMS at 1 year after surgery was 6.7 points, and at 2 years, it was 6.3 points. In our study, the difference between the groups after 38 months was 5.3 points, which puts this result on the verge of clinical significance. In addition, 43% of patients (13 of 30) primarily assigned to the LHBT augmentation group had an MCID in the CMS > 6.3 after 2 years of follow-up. The results may have been biased by the surgeon's initial conclusion regarding the viability of LHBT augmentation, as the final appraisal of the structure was made intraoperatively.

Radiologic assessment was a crucial part of the outcome measures in this study. Postoperative comparison of MRI results using the Sugaya scale showed better results in the study group than in the control group: 3.5 ± 1 vs. 4.1 ± 0.9 ($P = .035$). Moreover, the retear rate of the reconstructed rotator cuff in the study group was 43.3%, whereas in the control group, it peaked at 73.3% ($P = .036$). Yoshida et al[37] proved that the results on the Sugaya scale correlate with muscle strength after surgery, whereas Malavolta et al[27] confirmed the correlation between the scores on this scale and the assessment of pain after surgery. Lubiatowski et al[26] proved that retear of the rotator cuff after reconstruction was associated with a decrease in the isokinetic strength of the shoulder. Therefore, better quality of the reconstructed tendon corresponds with a better functional score, which may also explain the statistically better CMS in the study group. The results on the Sugaya scale obtained in this study correlate with the results of Chiang et al,[5] who also observed improved outcomes with LHBT augmentation compared with PR. Similarly, Cho et al[6] in a case-control MRI study noted a recurrence of tendon injury in 41.7% of patients treated with PR with LHBT augmentation and in as many as 73.7% of patients treated with PR alone. The results of Cho et al are practically identical to observations from our study. In other research studies comparing the results after PR with LHBT augmentation vs. PR alone, no statistically significant superiority in healing with augmentation was observed, although the percentage of retear recurrence was consistently lower in the LHBT augmentation group.[17,30] It should be noted that the aforementioned MRI results may have been influenced by the fact that the studies were conducted shortly after surgery, typically at 6 or 12 months.[17,30] Additionally, the use of a frontal-oblique projection to assess the recurrence of damage was not standardized across the aforementioned studies.

On the final radiographic assessment, we observed a statistically significant improvement in the AHD in the study group compared with the control group (5.9 ± 2 mm vs. 4.7 ± 1.3 mm, $P = .021$). The results on the Hamada scale were on the verge of statistical significance ($P = .083$), with scores of 2.3 ± 0.8 in the study group and 2.7 ± 0.9 in the control group, suggesting that both groups exhibited features of rotator cuff arthropathy. However, the AHD of 5.9 mm found in the study group falls into a gray zone between Hamada grade 1 (AHD > 6 mm) and Hamada grade 2 (AHD < 5 mm), indicating the possibility of better centralization of the humeral head with PR and LHBT augmentation. Similar findings with improved AHDs were observed by Chiang et al.[5]

The strength of our study lies in its consistent methodology for evaluating results, as all data were collected by the same author in a single hospital using standardized measurement methods. Additionally, the imaging studies, including MRI, radiographic, and ultrasound examinations, were performed using the same equipment and under the same conditions, enhancing the comparability of the results obtained.

Limitations

The main limitation of this study is the lack of a complete comparison between preoperative and postoperative imaging studies in both groups to better assess the impact of augmentation. Unfortunately, many of the patients included in the study underwent surgical procedures many years earlier, and the imaging results were lost over time. Also worthy of mention is the absence of shoulder strength comparisons preoperatively vs. postoperatively. Nonetheless, preoperative strength measurements would have been biased because of the severity of rotator cuff damage with associated pain, thus deterring many patients from exerting themselves. We are performing ongoing prospective research aiming to address the aforementioned limitations.

Conclusion

The treatment of massive, irreparable posterosuperior RCTs with PR with LHBT augmentation results in a lower retear rate and better centralization of the humeral head compared with PR alone. Furthermore, LHBT augmentation provides patients with superior functional outcomes measured by the CMS.

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Patient consent: Informed consent was obtained from all individuals participating in this study.

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