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Clinical effectiveness of superior capsular reconstruction using Teflon felt graft in the elderly for pain relief: a comparison using tensor fascia lata graft

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Background: The graft material generally used in superior capsular reconstruction (SCR) may be a human dermal allograft or an autologous tensor fascia lata (TFL) graft. According to a previous biomechanical study, a dermal graft (3 mm) was found to be insufficient and a thicker and stiffer graft was required. However, graft-site mobility should be considered when harvesting TFL, especially in the elderly. We have used Teflon felt as a graft material for SCR in the elderly for pain relief. This study aimed to compare the pain-relieving effects and clinical outcomes between Teflon felt and TFL graft.

Methods: This study included 39 patients (Teflon felt group: 19 patients, TFL group: 20 patients) who underwent SCR with a minimum of 2-year follow-up. Patients with painful irreparable rotator cuff tears but with shoulder elevation (abduction or flexion) of at least 130° were included in the study. Shoulder range of motion, acromiohumeral distance, and the numerical rating scale were evaluated preoperatively and 2 years postoperatively.

Results: There were no significant differences between the Teflon felt and TFL groups in terms of shoulder elevation (151 ± 33° vs. 164 ± 15°, $P = .57$), acromiohumeral distance (8.3 ± 2.2 mm vs. 7.5 ± 2.5 mm, $P = .14$), and numerical rating scale (1.0 ± 1.2 vs. 0.9 ± 0.8, $P = .93$).

Conclusion: SCR with Teflon graft provided pain relief equivalent to TFL graft. It may be an effective treatment option in elderly patients for irreparable rotator cuff tears with respect to pain relief.

Unlike physical laborers or active, young individuals, the primary need for elderly individuals may be to go about their daily lives without pain. Conservative treatment, including rehabilitation, is the first choice of treatment for such patients. However, conservative treatment is sometimes not successful and patients have persistent pain, leading to the need for alternative treatment options. Reverse total shoulder arthroplasty may not be a standard indication for patients with preserved shoulder function in some countries, even if there are irreparable rotator cuff tear and osteoarthritic changes. Superior capsular reconstruction (SCR) has recently been considered a surgical option with good clinical outcomes for patients with irreparable rotator cuff tears or shoulder pseudoparalysis in the absence of osteoarthritic changes in the glenohumeral joint.[5,24,27,44] The graft material generally used for reconstruction may be a human dermal allograft or an autologous tensor fascia lata (TFL) graft.[5,16,27,36,44] The results of previous biomechanical studies concluded that a graft stiffness and thickness of 6 mm is required.[21,26,27] A previous study demonstrated that grafts of sufficient and optimal thickness could be obtained by harvesting the TFL, including the muscular septum of the gluteus muscle[22]; however, if the TFL is harvested, graft site mobility should be considered.[43] There is a concern that harvesting the TFL, especially in elderly individuals, may result in postoperative thigh pain and hematoma that impairs motor function.[43] Additionally, patients sometimes refuse to harvest the TFL as a graft material. A previous study has successfully demonstrated the use of Teflon felt as a graft material for SCR in the elderly for pain relief.[35] However, a comparison of the clinical outcomes of using a Teflon felt graft versus an autologous TFL still remains unclear. The hypothesis of this study was that SCR using a Teflon felt graft can provide pain relief and exhibit comparable clinical outcomes compared to SCR using a TFL graft. This study aimed to compare the pain-relieving effects and short-term clinical outcomes of these 2 grafts.

This study was approved by the ethical committee of Kurashiki Central Hospital (approval number 3905). Patients provided written informed consent before enrolling in this study.

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Materials and methods

Study design and patient selection

This retrospective cohort study included patients who underwent SCR using either a Teflon felt or a TFL graft for treating irreparable rotator cuff tears involving the supraspinatus (SSP) and infraspinatus (ISP) or SSP, ISP, and subscapularis (SSC), performed by a single surgeon at a single institution. This study was approved by the institutional review board of our hospital (No. 3905). Informed consent was obtained from all patients prior to their enrollment in the study. Between September 2014 and January 2021, 39 patients underwent SCR. The inclusion criterion for SCR in this study was irreparable rotator cuff tears with a history of failed conservative treatment modalities, including painkillers, subacromial injections, and physiotherapy, supervised by physiotherapists for > 6 months. All patients were classified as grade 2 or 3 according to the Hamada classification.[14] Goutallier grade ≥ 3[12] was evaluated using a magnetic resonance imaging (MRI) and was marked by fatty infiltration of the tendon or higher within the tendon, when retracted to the glenoid level.[10] A torn tendon that could not reach the original footprint after the release of soft tissues at the time of surgery was defined as irreparable rotator cuff tear. Another inclusion criterion was preoperative shoulder elevation (abduction or flexion) of at least 130°, because 130° of elevation is thought to be essential for conducting daily activities.[31] To precisely evaluate shoulder range of motion (ROM), lidocaine was routinely injected into the subacromial space preoperatively; patients whose ROM (abduction or flexion) improved more than 130° were considered to have a painful loss of elevation[3] and were included in this study. Patients who had infections in their shoulder joints or neurological disorders were excluded. Between September 2014 and July 2018, we performed SCR using TFL grafts; however, there were 2 patients who refused harvesting of the TFL and they thus, underwent SCR using Teflon felt graft. On the other hand, we performed SCR using Teflon felt graft between August 2018 and January 2021.

Of the 39 patients who underwent SCR in our institution, 19 consecutive patients who underwent primary SCR using a Teflon felt graft (mean 75.5 ± 5.3, range: 68-83 years) and 20 consecutive patients who underwent primary SCR using TFL graft (mean 68.5 ± 5.0, range: 57-76 years) with a minimum of 2 years of follow-up were included in this study. The mean observation period was 38 months (range: 24-81 months).

Physical examination and outcome assessment

All patients were followed up at 2, 3, 4, 5, 6, 8, 10, and 12 months postoperatively and every 12 months thereafter. Clinical data for this study were collected retrospectively from medical records. Shoulder ROM, with the exception of internal rotation, was evaluated using a goniometer. To evaluate internal rotation, the vertebral level at which the tip of the thumb could reach was converted to numerals, from the thigh (1 point: minimum) to the level of the first thoracic vertebra (20 points: maximum).[44] ROM was evaluated preoperatively and at 24 months postoperatively.

All patients were evaluated using the American Shoulder and Elbow Surgeons (ASES) score preoperatively and at 24 months postoperatively. ROM and the ASES score were evaluated in-person by physiotherapists who were not blinded. We also evaluated the preoperative condition of the rotator cuff using the Goutallier classification of SSP, ISP, SSC, and teres minor. The numerical rating scale (NRS) score was evaluated preoperatively and at 1, 6, 12, and 24 months postoperatively. The acromiohumeral distance (AHD) was evaluated preoperatively and at 24 months postoperatively using plain radiographs. In addition, the Hamada classification and treatment of the biceps tendon were recorded. Moreover, complications (including graft detachment or graft tear) associated with the surgery were investigated. All radiographic evaluations were performed by an orthopedic surgeon unaffiliated with the surgery. Postoperative graft tears were defined according to the Hasegawa's classification[15] and > Type IV was defined as a graft tear.

The Teflon graft was radiographically opaque (Fig. 1); therefore, the graft condition was routinely evaluated in all 19 patients using plain radiography and ultrasonography at the time of follow-up. If there were shoulder symptoms, such as shoulder pain, MRI was used to assess shoulder pathology.

In the TFL graft group, the graft condition was evaluated using MRI in all 20 patients at 12 months postoperatively, and at subsequent follow-ups, it was evaluated using ultrasonography.

Operative techniques

Teflon felt graft

Teflon felt (Bard PTFE: polytetrafluoroethylene Felt, C.R. Bard, Inc., Murray Hill, NJ, USA) was used as the graft source. A single layer of Teflon felt has thickness of 2.9 mm, and it can be stacked to use. All 19 patients underwent SCR using 2 layers (thickness: 5.8 mm) of Teflon felt (Fig. 2).

TFL graft

To make a thick graft, the muscular septum between the TFL and gluteus muscle was used along with TFL to secure the graft thickness of at least 6 mm.[24,26] The harvested fascia lata was doubled and sutured to create a thick and stiff graft (Fig. 3). Hemostasis was performed to prevent postoperative hematoma. In addition, the posterior transection was sutured to the anterior transection as much as possible to prevent the gluteus muscle from drooping and to reduce the dead space.

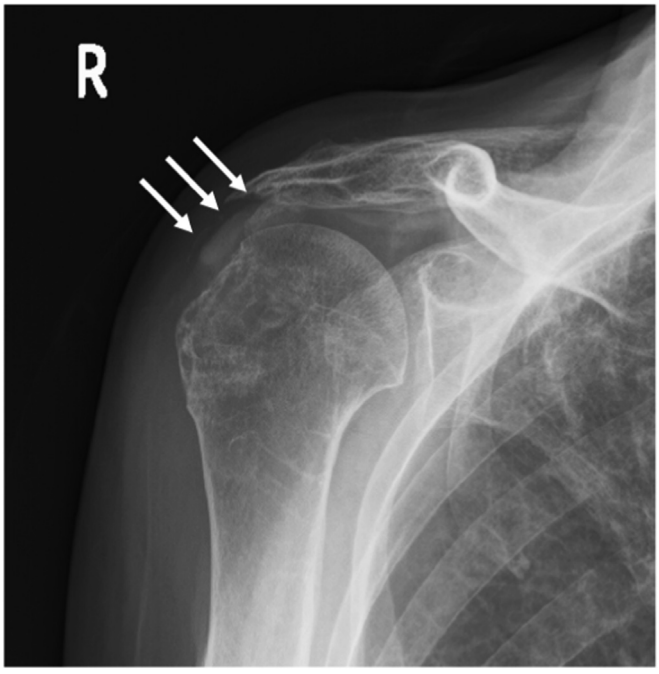

Figure 1 The plain radiograph anterior-posterior view shows that the Teflon felt graft is roentgenopaque.

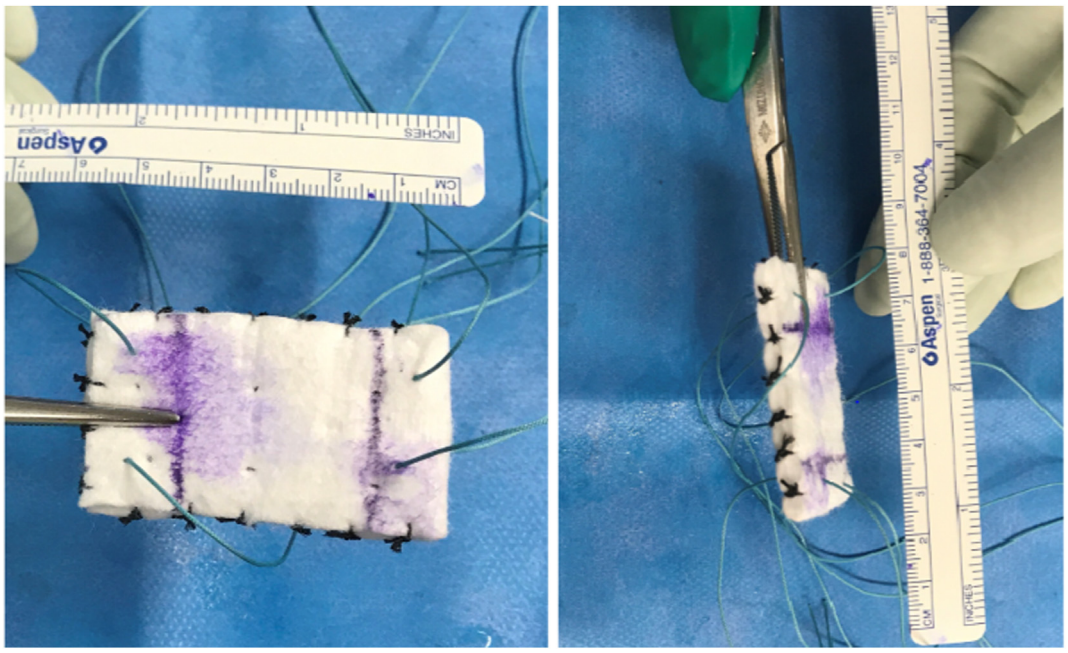

Figure 2 Two-layer Teflon felt graft with thickness of about 6 mm.

SCR

SCR was performed on patients in a beach chair position. While viewing the standard posterior portal, SSC was evaluated and repaired to the maximum possible extent using suture anchors. If the long head of the biceps was damaged (partial tendon tears or dislocation), tenotomy was performed; however, no treatment was performed if it was undamaged.

Figure 3 The TFL graft with a thickness of at least 6 mm. *TFL*, tensor fascia lata.

Arthroscopic instruments were moved into the subacromial space, and osteophytes on the undersurface of the acromion and distal clavicles were resected to enhance the space. If present, the scar tissue was débrided to ensure a field of view. If the torn tendons were found to be irreparable, the SSP and ISP defects were filled with the graft. Graft size was determined according to the method published by Mihata et al.[22-24] The distance from the anterior margin to the posterior margin of the torn tendon was defined as a defect in the anteroposterior direction. The distance from the superior margin of the glenoid to the lateral margin of the greater tuberosity at 30° shoulder abduction was defined as a defect in the mediolateral direction. The graft length in the anterolateral direction was the same as the length of the defect. The graft length in the mediolateral direction was 15 mm longer than that of the defect (Fig. 4).

Before inserting the suture anchors, unlike in the TFL group, abrasion to refresh the bone bed was not performed in Teflon felt group. Two bio-composite anchor in the glenoid (Corkscrew FT 4.5 mm; Arthrex, Naples, FL, USA) and 4 anchors (medial row: 2 anchors with tape material; lateral row: 2 anchors, SwiveLock 4.75 mm [Arthrex, Naples, FL, USA] or 5.5 mm FiberTape [Arthrex, Naples, FL, USA]) in the humerus were used to complete the suture bridge configuration with the shoulder abducted at 30° and humerus in neutral rotation (Fig. 5). The side-to-side suture technique between the graft and ISP or teres minor were not performed in Teflon felt group but were performed in the TFL group using 2 or 3 strong sutures (No. 2 FiberWire; Arthrex, Naples, FL, USA).

Postoperative rehabilitation

The 19 patients who underwent SCR with Teflon felt graft wore an abduction sling with the shoulder abducted at 45° for 4 weeks. Active exercises of the fingers, wrists, and elbows were performed starting the day after surgery. Passive exercises of the shoulder joint and active-assisted exercises with the patients in the supine position were started on postoperative day 4 and at 4 weeks, respectively. Active exercises in the sitting posture were started at 6 weeks and strengthening exercises were initiated after a minimum 4-month period.

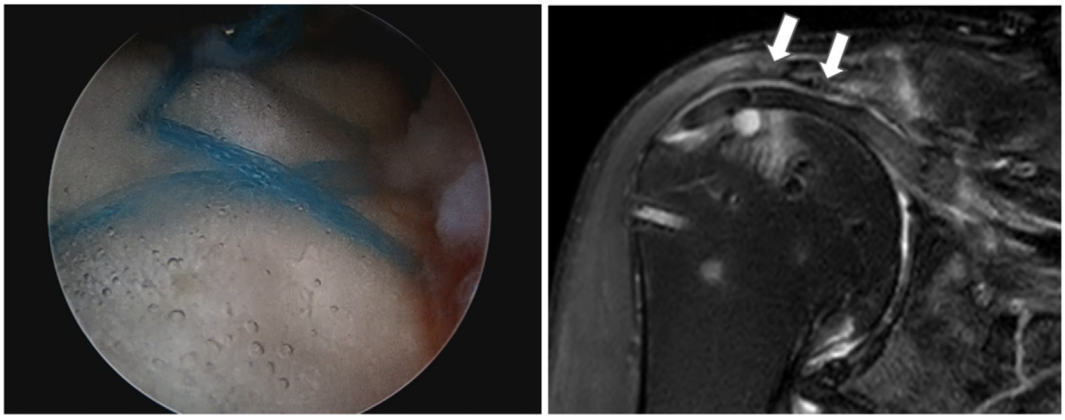

Figure 4 The Teflon felt graft is fixed with suture bridge configuration with the shoulder abducted at 30°.

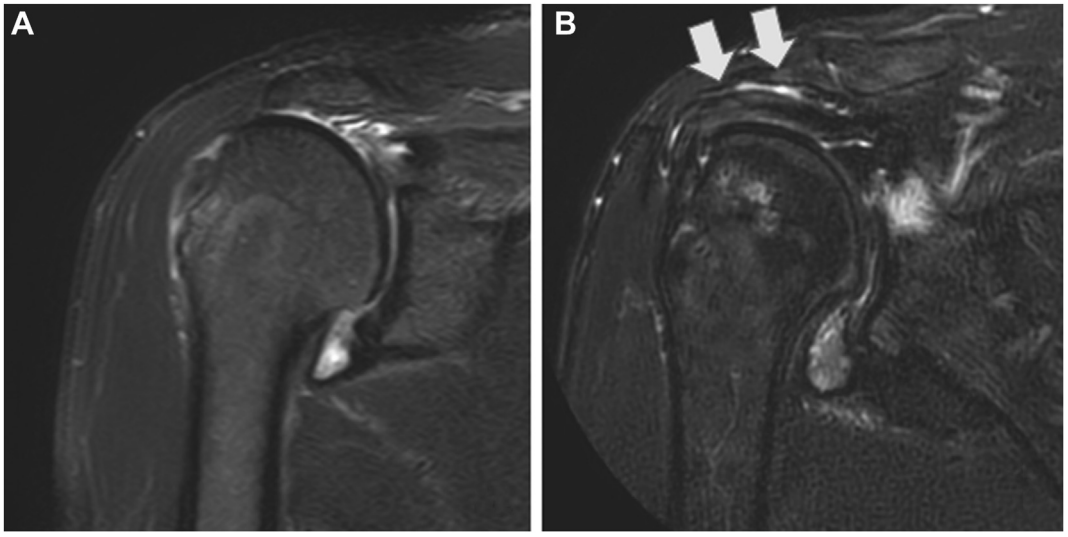

Figure 5 (A) Preoperative state. (B) Postoperative state. The humeral head is covered with the TFL graft. *TFL*, tensor fascia lata.

The 20 patients who underwent SCR with TFL graft wore an abduction sling with the shoulder abducted at 45° for 6 weeks. Active exercises of the fingers, wrists, and elbows were performed starting the day after surgery. Passive exercises of the shoulder joint, ad active-assisted exercises with the patients in the supine position, and active exercises in the sitting posture were started on postoperative day 4, at 5 weeks, and at 8 weeks, respectively. Strengthening exercises were initiated until at least 5 months postsurgery.

In the case of SSC repair, both passive flexion and abduction exercises were performed at <90° until 2 weeks after surgery, which were adopted in both groups.

Statistical analyses

The averages of continuous variables (e.g., ROM and age) were compared using the Mann-Whitney U test, and categorical variables (e.g., sex, the dominant hand involved, and Hamada classification) using Fisher's exact tests. The Wilcoxon signed-rank test (with Bonferroni correction) was used to compare preoperative and postoperative ROM, AHD, ASES score, and NRS; $P < .05$ was considered significant. All statistical analyses were performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). More precisely, it is a modified version of the R commander designed to add statistical functions frequently used in biostatistics.

Results

Baseline characteristics of the study participants

Baseline characteristics of the study participants are listed in Table I. There were significant differences in patients' age, follow-up periods, Goutallier classification of tendons involved, and operation duration between the 2 groups. However, no significant difference was seen in status of rotator cuffs, Hamada classification, and the treatment of the long head of biceps. The teres minor was intact in all patients. Patients in this study had mild degeneration of the SSC tendon (Goutallier classification: 0.7 ± 0.7 vs. 1.2 ± 0.7).

Comparison of preoperative and postoperative states between the Teflon graft and TFL graft groups

A comparison of the preoperative and postoperative states between the 2 groups is shown in Table II. Postoperatively, active

Table I
Baseline characteristics of study participants.

	SCR with Teflon graft (n = 19)	SCR with TFL graft (n = 20)	*P* value
Age, y	75.4 ± 5.3 (range: 68-83)	68.5 ± 5.0 (range: 57-76)	.0015†
Follow-up periods, mo	33.2 ± 6.9 (range: 24-52)	41.0 ± 12.1 (range: 34-81)	.0013*
Dominant side	11 cases (58%)	15 cases (75%)	.32
Male	6 cases (32%)	12 cases (60%)	.11
Status of rotator cuffs	Irreparable SSP, ISP tear	Irreparable SSP, ISP tear	.32
	Intact SSC, Tm (n = 7)	Intact SSC, Tm (n = 7)	
	Irreparable SSP,	Irreparable SSP,	
	Partially repairable ISP tear	Partially repairable ISP tear	
	Intact SSC, Tm (n = 4)	Intact SSC, Tm (n = 3)	
	Irreparable SSP, partially repairable ISP tear	Irreparable SSP, partially repairable ISP tear	
	Repairable SSC	Repairable SSC	
	Intact Tm (n = 3)	Intact Tm (n = 0)	
	Irreparable SSP, ISP tear	Irreparable SSP, ISP tear	
	Repairable SSC	Repairable SSC	
	Intact Tm (n = 5)	Intact Tm (n = 9)	
	Irreparable SSP, ISP, and SSC tear	Irreparable SSP, ISP, and SSC tear	
	Intact Tm (n = 0)	Intact Tm (n = 1)	
Hamada classification	Grade 2 (n = 10)	Grade 2 (n = 5)	.11
	Grade 3 (n = 9)	Grade 3 (n = 15)	
Treatment of LHB	Preserve: 6 cases	Preserve: 8 cases	.92
	Tenotomy: 9 cases	Tenotomy: 8 cases	
	Defect: 4 cases	Defect: 4 cases	
Goutallier classification	SSP: 3.0 ± 0.0	SSP: 3.5 ± 0.5	.0053†
	ISP: 2.8 ± 0.4	ISP: 3.4 ± 0.5	<.001†
	SSC: 0.7 ± 0.7	SSC: 1.2 ± 0.7	<.001†
Operation duration, min	91.0 ± 9.3	149.8 ± 29.9	<.001†
Graft thickness, mm	6 ± 0	8 ± 1 (6-11)	<.001†

Continuous variables are presented as mean ± standard deviation, with the range in parenthesis.
SCR, superior capsular reconstruction; *SSP*, supraspinatus; *ISP*, infraspinatus; *SSC*, subscapularis; *Tm*, teres minor; *LHB*, long head of biceps; *TFL*, tensor fasica lata.
*$P < .05$.
†$P < .01$.

external rotation and ASES score were significantly better in the TFL group.

Comparison of preoperative and postoperative states in the Teflon graft and TFL graft groups

A comparison of preoperative and postoperative state in the 2 groups is shown in Table III. There were significant differences observed in internal rotation, the ASES score, AHD, and the NRS in both groups. In Teflon graft group, there was no significant difference in AHD between immediate after surgery and 2 years postoperatively (9.2 ± 1.5 mm vs. 8.7 ± 2.2 mm, $P = .27$) (Fig. 6).

The temporal changes in the NRS scores in both groups are shown in Fig. 7. The mean NRS score at 1 month postoperatively was 2.0 and was significantly improved from that preoperatively (the power post hoc analysis: 1.0, level of significance: 0.05). Additionally, no significant difference was observed compared with that of TFL graft groups ($P = .37$).

Complications

A summary of the complication is shown in Table IV. In Teflon graft group, 1 patient demonstrated progression of osteoarthritic changes in the glenohumeral joint, and the shoulder elevation at 24 months postoperatively was worse than that of the preoperative state (Fig. 8). One patient, diagnosed with amyotrophic lateral sclerosis, did not maintain shoulder function. There were no graft tear, postoperative infections, and foreign-body reactions observed in the Teflon graft group.

In TFL graft group, 3 patients had complete graft tear at greater tuberosity side (Hasegawa's classification: Type IV, 3 cases), and 2 of the 3 patients were in their 60s, engaged in manual work. However, their shoulder function was preserved; therefore, no additional surgery was required.

Discussion

The main findings of this study were that SCR using a TFL graft resulted in significantly better ASES scores and active external rotation when compared to SCR using a Teflon felt graft. This result did not support our hypothesis that SCR using Teflon graft achieves clinical outcomes comparable to that of SCR using a TFL graft. Both grafts resulted in significantly improved ASES scores and AHD postoperatively. In addition, SCR using a Teflon felt graft provided pain relief that was comparable to SCR using a TFL graft.

It is estimated that approximately 50% of patients aged 70-90 years have rotator cuff tears.[47] Of these, up to 40% are considered massive rotator cuff tears,[1,13] some of which are defined as irreparable due to tendon retraction to the glenoid level and severe muscle atrophy of the torn tendon.[17] There are many surgical options for irreparable rotator cuff tears, such as débridement with acromioplasty,[19] partial repair,[6,7,18] tendon transfer,[11,30,32,41,45] reverse total shoulder arthroplasty,[8,29] subacromial balloon spacer,[9,40,46] patch graft,[7,33,36,42] and SCR.[5,16,21-27,43,44] SCR provides pain relief and improves shoulder function in patients with irreparable rotator cuff tears.[5,16,21-27,43,44] Moreover, it can be performed arthroscopically; therefore, it may be a viable option for the elderly. A previous study reported that SCR using a TFL autograft resulted in a higher graft healing rate than a human dermal allograft.[22-24] To restore the superior stability of the glenohumeral joint, the graft should be at least 6-mm thick, and in terms of graft thickness, a human dermal allograft (3 mm) is not sufficient[21,26,27] and is also associated with high medical costs. In addition, the human dermal allograft is not available in all countries. However, the option of harvesting the TFL for SCR might not be accepted by patients,

Table II
Comparison of preoperative and postoperative states between the Teflon graft and TFL graft groups.

	Preoperative		Postoperative	
	Teflon felt (n = 19)	TFL graft (n = 20)	Teflon graft (n = 19)	TFL graft (n = 20)
Flexion, °	137 ± 19 (120-170) $P = .043$*	150 ± 22 (90-170)	151 ± 33 (60-170) $P = .57$	164 ± 15 (120-170)
Abduction, °	133 ± 23 (90-170) $P = .12$	143 ± 26 (90-170)	151 ± 35 (60-170) $P = .29$	164 ± 16 (120-170)
External rotation, °	40 ± 17 (5-60) $P = .15$	48 ± 22 (0-85)	36 ± 17 (5-70) $P = .032$*	50 ± 19 (0-80)
Internal rotation	8 ± 3 L1 (4-15) $P = .26$	10 ± 4 Th11 (2-15)	12 ± 4 Th9 (4-17) $P = .37$	11 ± 4 Th10 (5-17)
ASES score	55.8 ± 6.4 (46.6-74.9) $P < .001$†	53.5 ± 5.4 (54.9-79.9)	82.3 ± 15.9 (60.3-96.6) $P = .015$*	92.6 ± 3.5 (86.6-98.3)
AHD, mm	4.3 ± 2.2 (1.0-7.4) $P = .64$	4.6 ± 2.0 (1.0-8.2)	8.7 ± 2.2 (3.0-13.4) $P = .14$	7.5 ± 2.5 (2.3-11.6)
NRS	5.8 ± 0.6 (5-7) $P = .98$	5.9 ± 1.2 (4-8)	1.0 ± 1.2 (0-4) $P = .93$	0.9 ± 0.8 (0-2)

AHD, acromio humeral distance; *ASES*, American Shoulder and Elbow Surgeons; *L*, lumbar level; *NRS*, numerical rating scale; *Th*, thoracic level; *TFL*, tensor fascia lata.
Continuous variables are presented as mean ± standard deviation, with the range in parentheses.
*$P < .05$.
†$P < .01$.

Table III
Comparison of preoperative and postoperative state in the Teflon graft and TFL graft groups.

	SCR with Teflon graft (n = 19)		SCR with TFL graft (n = 20)	
	Preoperative	Postoperative	Preoperative	Postoperative
Flexion, °	137 ± 19 (120-170) $P = .11$	151 ± 33 (60-170)	150 ± 22 (90-170) $P = .023$*	164 ± 15 (120-170)
Abduction, °	133 ± 23 (90-170) $P = .095$	151 ± 35 (60-170)	143 ± 26 (90-170) $P = .0079$†	164 ± 16 (120-170)
External rotation, °	40 ± 17 (5-60) $P = .43$	36 ± 17 (5-70)	48 ± 22 (0-85) $P = .69$	50 ± 19 (0-80)
Internal rotation, °	8 ± 3 L1 (4-15) $P = .012$*	12 ± 4 Th9 (4-17)	10 ± 4 Th11 (2-15) $P = .022$*	11 ± 4 Th10 (5-17)
ASES score	55.8 ± 6.4 (46.6-74.9) $P < .001$†	82.3 ± 15.9 (60.3-96.6)	53.5 ± 5.4 (54.9-79.9) $P < .001$†	92.6 ± 3.5 (86.6-98.3)
AHD, mm	4.3 ± 2.2 (1.0-7.4) $P < .001$†	8.7 ± 2.2 (3.0-13.4)	4.6 ± 2.0 (1.0-8.2) $P < .001$†	7.5 ± 2.5 (2.3-11.6)
NRS	5.8 ± 0.6 (5-7) $P < .001$†	2.0 ± 1.2 (0-4)	5.9 ± 1.2 (4-8) $P < .001$†	0.9 ± 0.8 (0-x2)

ASES, American Shoulder and Elbow Surgeons score; *Th*, thoracic level; *L*, lumbar level; *AHD*, acromio humeral distance; *SCR*, superior capsular reconstruction; *TFL*, tensor fascia lata; *NRS*, numeric rating scale.
Continuous variables are presented as mean ± standard deviation, with the range in parentheses.
*$P < .05$.
†$P < .01$.

especially in the elderly. For elderly patients with functional but painful shoulders, the goal of surgery is to relieve pain; however, pain at the graft harvest site may not be acceptable. In our study, the use of Teflon in 2 patients who refused TFL harvesting resulted in sufficient pain relief and was the starting point for a change in graft material. Teflon felt has been used in thoracic, cardiovascular, and shoulder surgery for conventional patch grafting.[36,42] Teflon felt is approximately 3 mm thick and can be stacked for use; therefore, when performing SCR using Teflon felt grafts, grafts of at least 2 layers are necessary.[34]

Previous studies reported that conventional patch graft surgery using Teflon felt grafts improved short-term clinical outcomes[36,42]; however, the graft tear rate was high[28] as it only partially restored superior stability.[27] SCR using a Teflon felt graft was first reported by Okamura[35] et al for patients with irreparable rotator cuff tears and good clinical and radiographic outcomes were demonstrated.[34] In this technique, they used 3-layer grafts which were not fixed to the glenoid or greater tuberosity by suturing (cable graft); thus, the Teflon graft could move during shoulder motion. In their study, shoulder ROM, abduction strength, the ASES score, and AHD were reported to improve, with low rates of graft tear; however, the AHD was significantly smaller 1 year after SCR than that immediately after the SCR.[34] In our study, the graft was fixed on the glenoid and greater tuberosity using suture bridge configuration, there was no significant difference in AHD immediately after surgery and 2 years postoperatively (9.2 ± 1.5 mm vs. 8.7 ± 2.2 mm, $P = .27$). This unfixed cable graft as reported by Okamura[34] et al may be expected to have the same spacer effect as that of a balloon spacer. A previous study reported that the balloon spacer was degraded in 50% of the patients after 6 months.[37] On the contrary, the tension effect has a larger role in superior stability in the glenohumeral joint than the spacer effect.[21,34] Therefore, we believe that fixing the Teflon graft to the glenoid and greater tuberosity following the Mihata's method is important.

In this study, 25 patients (25/39, 64%) underwent rotator cuff repair and SCR. Partial repair alone has been reported to have a high retear rate and insufficient clinical outcomes, even in the short term.[2,4,38] Previous cadaveric biomechanical studies demonstrated that the humeral head translated superiorly by approximately 3.5 mm at 0° of shoulder abduction in a massive rotator cuff tear[39];

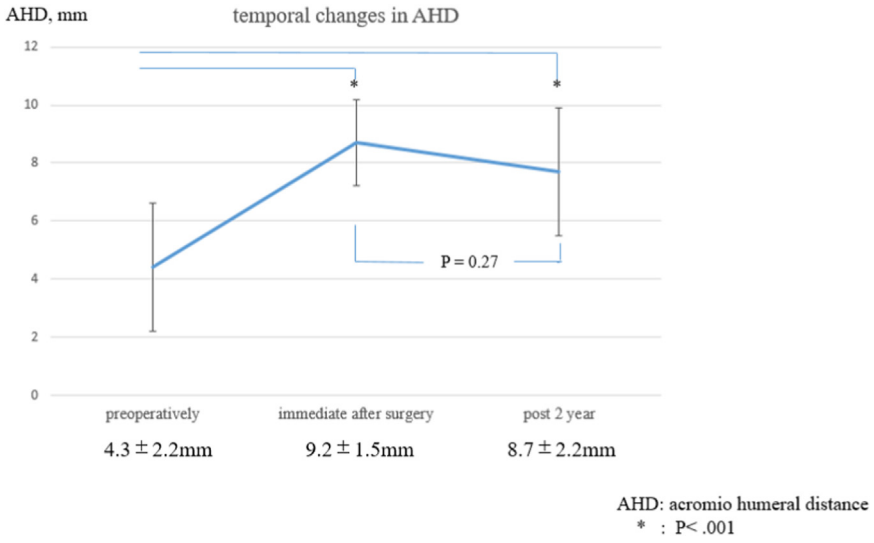

Figure 6 The acromio-humeral distance is significantly larger 2 years after superior capsular reconstruction than preoperatively. There is no significant difference in acromio-humeral distance between immediate after surgery and that 2 years postoperatively.

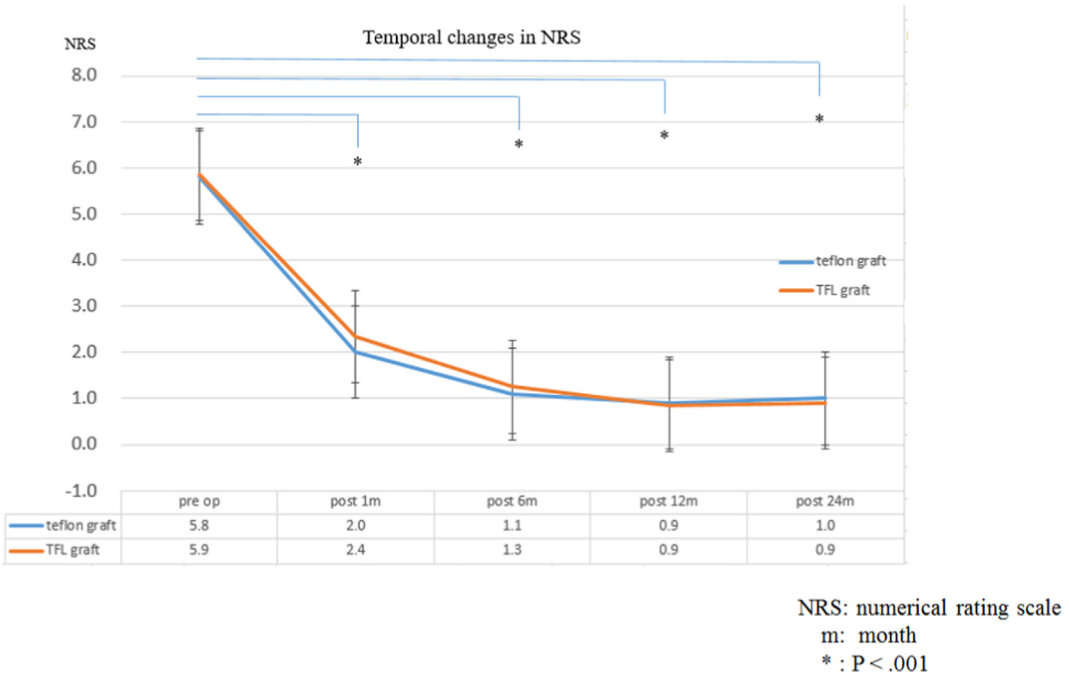

Figure 7 The numerical rating scale in 1, 6, 12, and 24 months postoperatively are significantly improved than those preoperatively.

thus, the repaired rotator cuff may be abraded under the acromion during daily motion and may cause deterioration of the shoulder function. However, SCR can decrease the superior translation and subacromial peak contact pressure.[24] Therefore, combining SCR with partial rotator cuff repair may be useful to prevent retear of a repaired rotator cuff by reducing subacromial impingement.

One patient demonstrated progression of osteoarthritic changes in the glenohumeral joint. In this patient, a slight osteoarthritic change (or osteonecrosis) was noted at the top of the humeral head on the preoperative MRI. A cadaveric study demonstrated that placement of the subacromial spacer increased glenohumeral contact pressure,[20] and this increased contact pressure in the glenohumeral joint which may cause progression of osteoarthritic change. Therefore, the indications for SCR in patients with cartilage damage including Hamada grade 4 may be controversial.

The operation duration in the TFL graft groups was significantly longer than in the Teflon felt group. It required time to harvest the TFL and prepare the graft. In addition, the graft at 8 ± 1 mm thick presented technical difficulty in handling under the subacromial space, which may have contributed to the longer operation duration. There was a significant difference between grafts in terms of active external rotation. In addition, in the TFL group, there was a significant improvement in flexion, abduction, and internal rotation from preoperatively to postoperatively, but not significantly so in the Teflon felt group. This suggests that a TFL graft which has biological healing potential should be used when functional recovery

Table IV
Summary of the complications.

	Status	Complications	Functional results	Additional surgery
79-y-old female	Hamada grade 3 irreparable SSP Partially repairable ISP Repairable SSC Teflon graft	Progression of osteoarthritic changes	Shoulder elevation <90°	None
71-y-old male	Hamada grade 3 irreparable SSP, ISP Intact SSC Teflon graft	Amyotrophic lateral sclerosis	Shoulder elevation <60°	None
68-y-old male	Hamada grade 3 irreparable SSP, ISP Intact SSC TFL graft	Complete graft tear at greater tuberosity	Shoulder elevation >150°, No pain	None
71-y-old male	Hamada grade 2 irreparable SSP, ISP, SSC TFL graft	Complete graft tear at greater tuberosity	Shoulder elevation >150°, No pain	None
61-y-old male	Hamada grade 3 irreparable SSP, ISP Intact SSC TFL graft	Complete graft tear at greater tuberosity	Shoulder elevation >150°, No pain	None

SSP, supraspinatus; *ISP,* infraspinatus; *SSC,* subscapularis; *TFL,* tensor fascia lata.

is the purpose of surgery in addition to pain relief. The significant difference in postoperative external rotation between the 2 grafts may be due to the side-to-side suture between the graft and tendon in the TFL graft group which reconstructs a tendon stop for the posterior residual tendon. There was also a significant difference in the postoperative ASES score. The fact that patients in the Teflon felt groups were significantly older than those in the TFL group and that 2 of the patients' (osteoarthritic change and amyotrophic lateral sclerosis) ROM deteriorated further than preoperatively may have contributed the significant difference in the ASES score.

Considering the fact that sufficient pain relief was achieved even at 1 month postoperatively and no significant difference was observed in the postoperative NRS between the 2 groups, SCR using Teflon felt graft may be an effective treatment in terms of pain relief. There were 3 patients with complete graft tears in TFL graft group (Table IV); however, there were no graft tear observed in the Teflon felt group. Patients in the TFL group were significantly younger and may be more active, which may have contributed the high rates of graft tears (3/20 cases, 15%). However, in these 3 cases of graft tears (Hasegawa's classification Type IV), the side-to-side sutures between the graft and the residual posterior cuff tendon were preserved and AHD was improved from the preoperative state. These factors may have contributed to the fact that the graft tear did not translate into a functionally impaired shoulder. In contrast, SCR with Teflon felt grafts cannot have side-to-side sutures performed. Therefore, it is unclear whether similar results would be obtained if a graft tear occurred in the Teflon graft group.

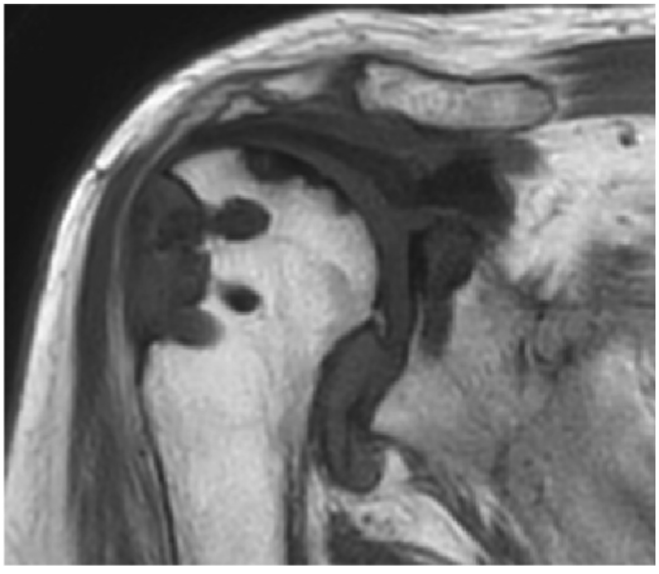

Figure 8 A progression of osteoarthritic change is noted at 2 years postoperatively.

The Teflon graft cannot be expected to biologically heal to the bone, and the sutures and Teflon graft may be abraded with time. Therefore, for active and young individuals, using autografts or allografts, which have biological healing potential, should be considered. Nevertheless, for pain relief in inactive elderly individuals, SCR using Teflon felt graft may be a viable option for irreparable rotator cuff tears.

This study had some limitations. First, it was a retrospective study, and patients included in this study were not randomized; thus, potential selection bias should be considered. Second, the number of patients was relatively small and the follow-up periods were relatively short; therefore, further follow-up should be necessary to investigate the long-term survival rate of Teflon graft. Third, postoperative MRI was not performed in all patients with Teflon graft because biological healing was not expected with the graft (only 8 patients). Furthermore, there are differences in the evaluation method for graft tears between the TFL graft and Teflon graft groups and the validity of assessing graft tears with plain radiographs or ultrasonography is unknown. Fourth, 64% (25/39 cases) of the patients underwent SCR in conjunction with rotator cuff repair and acromioplasty; thus, the true effect of SCR alone was not compared between the 2 groups. Nevertheless, we believe that the findings of this study demonstrating the clinical effectiveness of SCR using Teflon felt graft with respect to pain relief have clinical relevance.

Conclusion

Contrary to our hypothesis, SCR using a TFL graft resulted in significantly better ASES scores and active external rotation when compared to SCR with a Teflon felt graft. However, SCR with a Teflon felt graft provided pain relief equivalent to SCR with a TFL graft in the short term. We believe that SCR using a Teflon felt graft represents a viable alternative to existing arthroscopic procedures in elderly patients with painful irreparable rotator cuff tears refractory to conservative treatment.

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