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Patient-Reported Outcomes of Achilles Tendon Repair Using the Modified Gift-Box Technique With Nonabsorbable Suture Loop: A Consecutive Case Series

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ABSTRACT

We sought to determine the early range of motion, complication rates, and 1-year patient-reported outcomes following Achilles tendon repair, using a modified gift-box suture loop technique. Sixty consecutive patients (49 males, mean age 36.2 ± 9.9 years) who underwent Achilles tendon repair with a modified gift-box suture loop technique performed by a single surgeon were prospectively enrolled. The range of motion at the final follow-up visit (mean 6 months) and the Achilles tendon rupture score (ATRS) and the complication rates at 1 year were obtained with 83% follow-up. The predictors of complications and ATRS were assessed. The mean operative time was 63.1 ± 10.8 minutes, which decreased throughout the case series ($r = 0.46$, $p < .001$). The mean plantarflexion at the final office evaluation was 31.7° ± 6.2°, dorsiflexion was 11.7° ± 6.3°, and total ankle arc of motion was 43.6° ± 9.7°; longer length of follow-up was associated with greater dorsiflexion ($p = .008$) and the total arc of motion ($p = .008$) but not with plantarflexion ($p = .16$). The overall rerupture rate was 1.7% (1 patient), wound complication rate was 1.7% (1 patient), and the overall complication rate was 6.7% (4 patients). No predictors of complications were identified. Complication rates did not differ between the first 30 (6.7%) cases and second 30 (6.7%) cases. The mean ATRS at 1 year was 81.8 ± 16.8 points. The rerupture and overall complication rates by 1 year were low. The range of motion, particularly dorsiflexion, improved through at least 6 months. Diabetic patients had lower 1-year ATRS than nondiabetic patients using this technique.

The Achilles tendon is not only the strongest and thickest tendon in the body but is also 1 of the most commonly injured. Ruptures typically occur in the third or fourth decade of life and are more common in males (1,2). The annual rate has been reported to be as high as 18 per 100,000 person-years in the general population and continues to rise owing to the increased rate of participation in high-demand sporting activities among adults (3). Achilles ruptures are typically the result of noncontact injuries caused by a forced plantarflexion of the foot with an extended knee or rapid eccentric dorsiflexion in a plantarflexed foot (4). Numerous operative and nonoperative treatment protocols have been described, with operative management typically resulting in lower rerupture rate and earlier mobilization and return to sport, with a success rate of 85% to 95%. However, the risks inherent to any surgical procedure, including wound and skin complication (4,5), are still a concern when managing Achilles ruptures operatively. The risks of nonoperative treatment include rerupture, lack of strength owing to tendon elongation, and extended time to return to full function (6,7).

The primary goals of Achilles tendon repair are to obtain maximal primary stability and to restore function to the gastrocnemius soleus complex. End-to-end Achilles tendon repair with suture is the gold-standard approach to acute open surgical intervention, with many variations in the technique, including the Bunnell, Kessler, Krackow, triple-bundle, and gift-box techniques (1). Percutaneous techniques have been described, but they have shown greater early elongation of the repair site than the traditional open-repair techniques in a cyclic loading study (8). The Krackow technique has been shown to be stronger than the Bunnell or Kessler technique (9), and the gift-box technique has been shown to be stronger than the Krackow (1) or Bunnell (10)

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technique in cadaver models. The gift-box technique has also had promising functional outcomes, with a mean American Orthopaedic Foot and Ankle Society ankle–hindfoot scale score of 93.2 ± 6.8 in a series of 44 patients at a mean of 35.7-month follow-up (11).

In a previous publication, a novel modification of the gift-box technique was described. It uses a continuous nonlocking, nonabsorbable suture loop in a modified gift-box configuration (FiberLoop®; Arthrex, Naples, FL) (12). To our knowledge, there are no current studies examining the results of gift-box repair performed using a suture loop. In general, regarding nonlocking loop constructs and the traditional Krackow locking stitch, previous studies have conflicting results when comparing elongation, gap formation, suture pullout, and failure (1,13–15). There is continued concern about passing large amounts of suture through what is known to be the hypovascular zone of the tendon (13). The gift-box technique helps to eliminate excess suture, without compromising on strength (1), whereas the use of a suture loop may allow for a more timely and efficient repair (12).

The purpose of this study was to determine complication rates and 1-year outcomes following Achilles tendon repair by using a novel modified gift-box suture loop technique. We hypothesized that outcomes for this novel technique would compare favorably with previously described techniques.

Patients and Methods

Data Collection

After institutional review board approval was obtained from our institution, the data were prospectively collected on a consecutive series of all patients undergoing primary Achilles repair, Current Procedural Terminology code 27650 (CPT®; American Medical Association, Chicago, IL), using the suture loop modified gift-box technique (12), from January 2013 through June 2017. This resulted in 72 surgeries, with complete 1-year data available for 60 surgeries (59 patients). One patient had a primary Achilles repair followed by a subsequent contralateral injury and primary Achilles repair; all other patients had unilateral injuries. A power analysis was conducted a priori, and a sample size of 60 was determined to be adequate to estimate the complication rates, with a 7.5% margin of error and mean Achilles tendon rupture score (ATRS) within a 4-point margin of error, with 80% power and alpha = 0.05.

Surgeries were performed at a single institution by a single sports medicine fellowship–trained surgeon. The exclusion criteria included patients <18 years of age, reruptures, concurrent associated injuries, worker's compensation cases, and incomplete postoperative follow-up. The data collected (by T.L.F., J.S.E., M.J., E.F., S.F., and J.K.) included age, gender, comorbidities, use of tobacco, and insurance status. Further data collection (by T.L.F., J.S.E., M.J., E.F., S.F., and J.K.) included time from injury to surgery, mechanism of injury, and operative time. Patients were then scheduled to be seen at standard 2-week, 6-week, 3-month, and 6-month postoperative time points. Range-of-motion measurements were taken at each visit, with their final visit's measures of plantarflexion, dorsiflexion, and total arc of motion being used for analysis. Patients were seen by the surgeon at each interval, and advanced providers were not used for the follow-up visits or measurement recordings.

Each patient was then contacted 1 year postoperatively (S.F. and J.K.) for a brief telephone interview, in which they were asked a series of 10 questions as part of the ATRS. Full ATRSs were not obtained at earlier postoperative time points. We were able to obtain 82% follow-up (59 of 72 patients); all patients in the consecutive series agreed to participate in the study, and all were successfully contacted at 1 year. Patients were aware that the outcome measures were being recorded but were not knowledgeable of the fact that the data for this specific technique have not been published previously. The ATRS is a reliable and validated patient-reported instrument developed to measure the outcomes related to daily living and physical activity after treatment following an Achilles rupture, scored 0 to 100, with a 100 being a perfect score, without any limitation or lifestyle change (6,16). The ATRS has now been validated in >10 cultures and languages (16–20). Although no study has specifically compared the validity of the ATRS administered via telephone versus other methods, the examination of the Patient-Reported Outcome Measure Information System scores has demonstrated no change in the recorded outcome metrics based on administration via voice, paper, or electronic means (21,22). Patients were also specifically asked if they had suffered from any postoperative complication in the 1 year since the surgery.

Surgical Technique

As described previously by Miller et al (12), both extremities are sterilely prepped and draped. The senior author (T.L.M.) performed the procedure, and resident physicians (T.L.F., J.S.E., M.J., and E.F.) assisted. An 8-cm to 10-cm longitudinal incision centered over the tear site is made at the posterior aspect of the ankle, just medial to the Achilles tendon. Careful dissection is made through the soft tissue to expose the paratenon, which is then incised sharply to create full-thickness flaps. The tendon is exposed, and the damaged ends of the tendon stumps are debrided sharply back to the stable and healthy-appearing tissue.

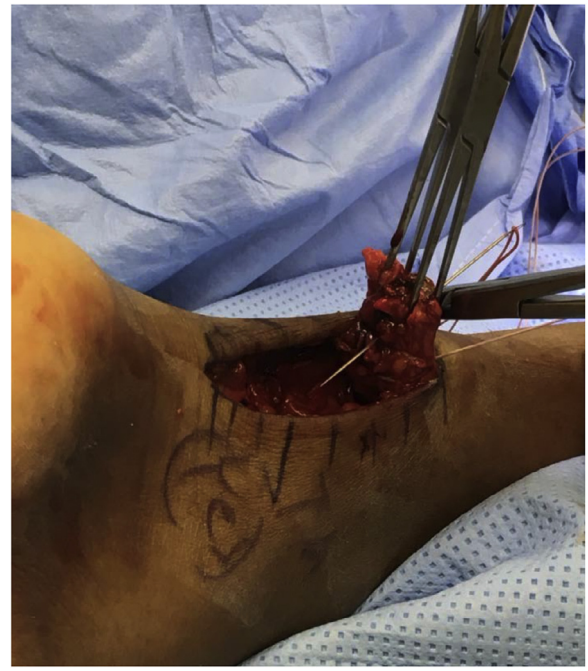

Fig. 1. Suture loop is woven through the proximal tendon stump.

The technique is similar to the gift-box technique described previously (1) but differs in that 1) a nonabsorbable suture loop is used rather than a traditional running suture; 2) after being tied over the superficial surface, both proximally and distally, the sutures ends are again brought back through the stump and tied together, to allow the knots to sit more flat; and 3) this secondarily reinforces the repair, because now, 6 suture strands span the rupture site rather than 4. The repair begins with a nonabsorbable suture loop woven in a repeating fashion 5 times through the distal and proximal stumps of the tendon, 1 suture loop for each tendon stump (Figs. 1 and 2). A sixth pass of the suture loop is made behind the position of the fifth pass on each stump to lock the suture. The tails of each of the 2 suture loops are then passed out through the ends of each stump (Fig. 3*A*). A modified gift-box repair is then performed by using a free needle to shuttle the ends of each of the 2 suture tails through the suture "tunnels" created in the opposite tendon stump. Knots are tied proximal and distal to the suture construct, with the ankle in the appropriate position of plantarflexion and with the tendon under appropriate tension (Fig. 3*B*). Tension is set with the knee in 90° of flexion and with the ankle set to the same degree of plantarflexion at which the uninjured ankle rests. Initially, 1 suture is tied statically, and the opposite is tied with tension applied. This step is performed to prevent

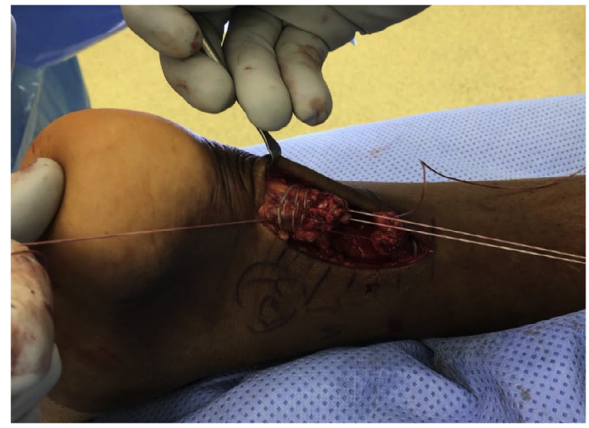

Fig. 2. Suture configuration of the distal stump.

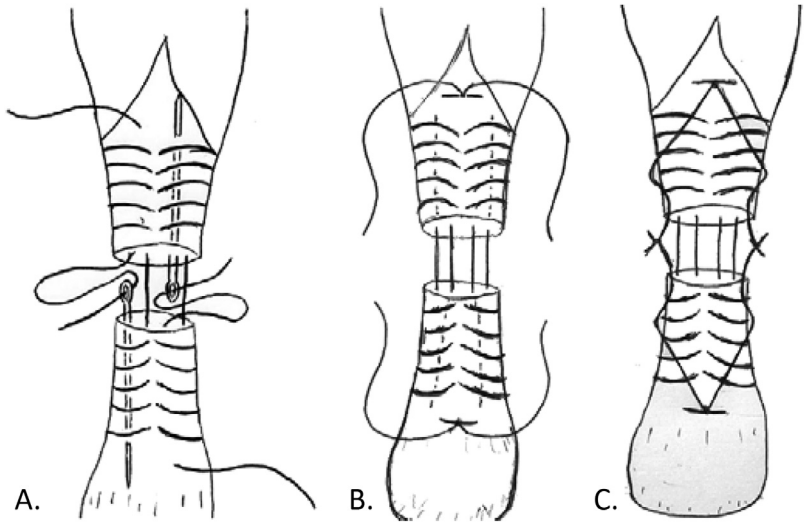

Fig. 3. (*A*) Suture ends from the distal and proximal stumps are passed through the opposite tendon stump with the Keith needle. (*B*) Suture knots are sequentially tied proximally and distally to the woven suture in each tendon stump. (*C*) The final suture configuration after repassage and typing of the medial and lateral suture tails. Drawn by T.L.M.

overtensioning of the repair. At this point, the suture tails are passed back across the sides of the repair site and tied under static tension (Figs. 3C and 4).

Postoperative Protocol

A posterior sugar-tong splint, with the ankle resting in approximately 15° of plantarflexion, is applied while still in the operating room (17). The patient remains non-weightbearing on the operative lower extremity for the first 2 to 3 postoperative weeks, at which point an accelerated rehabilitation program is initiated, as outlined by Miller et al (12).

Statistical Analysis

Statistical testing was performed (by J.S.E.) using a standard software package (JMP 13.0; SAS Institute, Cary, NC). One patient sustained a contralateral Achilles rupture that was later repaired. To minimize confounding and ensure independent observations, only the data related to the initial injury and surgery for this patient were included in the statistical analysis; however, complications related to both surgeries are reported. Descriptive statistics were first generated for the entire sample. The assumptions for parametric statistical tests, including normal distribution and equal variance, were met for all continuous variables in this study. A 2-tailed Fisher's exact test was used to compare the differences in the frequency of categoric variables. A 2-tailed Student's *t* test was used to compare the differences in means for continuous variables. The unadjusted association between the outcome variables (ATRS and range of motion) and patient age, time between injury and surgery, operative time, and length of the follow-up were assessed via the Pearson correlation and linear regression. A multivariate linear regression model using the standard least-squares method was used to determine the independent predictors of the ATRS at 1 year. Potential covariates were selected a priori and included patient age, tobacco use, diabetes, and insurance status. Finally, the relationships between the number of cases performed by the operating surgeon with the modified gift-box technique and operating room time, as well as complication rates, were assessed by linear regression and the Fisher's exact test, respectively.

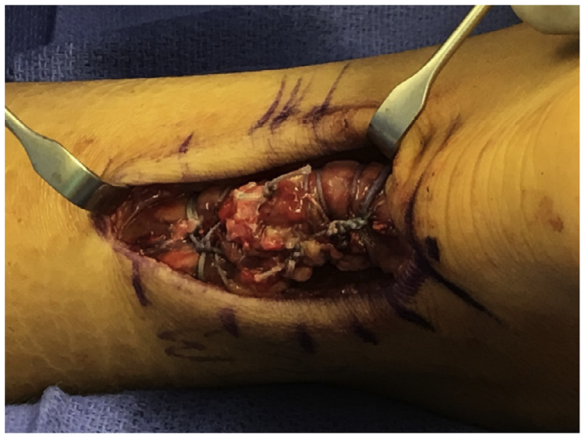

Fig. 4. Final completed tendon repair.

Results

Descriptive Statistics

The most common injury mechanism was basketball (n = 26, 43%), followed by volleyball (n = 3, 5%), soccer (n = 3, 5%), and football (n = 3, 5%); all other mechanisms occurred in <3 (<5%) patients (Table 1). The mean time from injury to surgery was 14.7 ± 10.9 (range 4 to 70) days. The mean operative time was 63.1 ± 10.8 minutes, which decreased throughout the case series ($r = 0.46$, $p < .001$). The mean ATRS at 1 year was 81.2 ± 16.5 points. The mean time to final in-office clinical evaluation was 24.3 ± 12.3 weeks. The mean plantarflexion at the final follow-up was 31.7° ± 6.2°, dorsiflexion was 11.8° ± 6.3°, and total ankle arc of motion was 43.4° ± 9.7°. Complications (n = 5) occurred in 4 (6.7%) of 60 cases; individual complications included deep vein thrombosis (2 [2.3%] patients), scar adhesion requiring return to the operating room (1 [1.7%] patient), superficial wound dehiscence requiring oral antibiotics (1 [1.7%] patient), and secondary Achilles tendon

Table 1
Demographics, symptom scores, medical history, and outcomes stratified by symptom status (N = 59, 60 surgeries)

Demographics, n (%)	
Female	11 (18.6)
Male	48 (81.4)
Age, y	36.2 ± 9.9
Smoking history, n (%)	
Current or former smoker	10 (16.9)
Nonsmoker	49 (83.1)
Diabetic, n (%)	2 (3.4)
Nondiabetic, n (%)	57 (96.6)
Insurance status, n (%)	
Insured	52 (88.1)
Uninsured	7 (11.9)

Data presented as mean ± standard deviation, unless otherwise noted.

Table 2
Differences in mean Achilles tendon rupture score and ankle range of motion by gender, smoking status, diabetes status, and insurance status (N = 59)

	ATRS (Points)	Ankle PF (°)	Ankle DF (°)	Arc of Motion (°)
Gender				
Female	75.6 ± 16.4	31.5 ± 4.7	13.2 ± 4.8	44.7 ± 6.5
Male	82.4 ± 16.2	31.7 ± 6.5	11.6 ± 6.6	43.2 ± 10.3
p Value	.22	.91	.44	.66
Smoking status				
Former or current smoker	76.9 ± 19.5	31.1 ± 3.3	13.0 ± 6.4	44.1 ± 6.4
Never smoked	82.0 ± 15.9	31.8 ± 6.7	11.5 ± 6.4	43.4 ± 10.2
p Value	.37	.76	.53	.84
Diabetes status				
Diabetic	51.5 ± 4.9	35.0 ± 7.1	10.0 ± 2.8	45.0 ± 4.2
Nondiabetic	82.2 ± 15.8	31.6 ± 6.2	11.1 ± 6.4	43.4 ± 9.8
p Value	.008	.44	.68	.82
Insurance status				
Insured	82.6 ± 16.2	31.9 ± 6.6	11.7 ± 6.5	43.6 ± 10.1
Uninsured	70.4 ± 15.6	30.0 ± 0	12.0 ± 5.1	42.0 ± 5.1
p Value	.07	.48	.93	.69

Data presented as mean ± standard deviation.
Abbreviations: ATRS, Achilles tendon rupture score; DF, dorsiflexion; PF, plantarflexion.

Table 3
Correlation between outcome measures, patient age, days between injury and surgery, and length of follow-up (N = 59)

	ATRS	Ankle PF	Ankle DF	Arc of Motion
Age				
Correlation coefficient	−0.09	−0.08	0.17	0.06
p Value	.51	.55	.22	.68
Days between injury and surgery				
Correlation coefficient	−0.04	−0.02	−0.05	−0.03
p Value	.75	.88	.67	.85
Time from surgery to final ROM evaluation				
Correlation coefficient	NA*	0.20	0.36	0.36
p Value	–	.16	.008	.007

Abbreviations: ATRS, Achilles tendon rupture score; DF, dorsiflexion; NA, not applicable; PF, plantarflexion; ROM, range of motion.
* ATRS were all obtained at 1-year follow-up.

rupture requiring repair (1 [1.7%] patient). One patient experienced 2 complications (deep vein thrombosis and superficial dehiscence). Of note, it was confirmed on surgical evaluation that the 1 patient who sustained a secondary tendon rupture on the surgically treated side sustained the second tear at a site near the calcaneal insertion and not at the midsubstance site where the original repair had been performed. It was determined that the original repair did not fail.

Range of Motion

There was no significant correlation between the ankle range of motion and gender, age, insurance status, or smoking status (Table 2). Ankle dorsiflexion and total arc of motion were increased with longer time between the surgery and the final in-office range-of-motion assessment (Table 3, Fig. 5). Ankle dorsiflexion, plantarflexion, and total arc of motion were not correlated with patient age and time between injury (Table 3).

Patient-Reported Achilles Tendon Rupture Score at 1 Year

Diabetics had significantly lower ATRS than nondiabetics (diabetic mean 51.5 ± 4.9 points, nondiabetic mean 82.2 ± 15.8 points; $p = .008$), and there was a trend toward lower ATRS among uninsured patients (mean 70.4 ± 15.6) versus insured patients (mean 82.6 ± 16.2; $p = .07$). There was no significant correlation between 1) gender or smoking status and 2) ATRS or ankle range of motion ($p \geq .05$, all comparisons) (Table 2). The ATRS at 1 year was not correlated with time between injury and surgery or patient age (Table 3), and there was no difference in the ATRS between males and females. In the multivariate model (Table 4), diabetes status was the only independent predictor of the ATRS at 1 year. Diabetics had mean 13.5 ± 6.0 points lower ATRS compared to nondiabetics, with adjustment for patient age, insurance status, and tobacco use status (F test $p = .03$). Age ($p = .84$), insurance status ($p = .19$), and tobacco use status ($p = .66$) were not the significant predictors of the ATRS in the multivariate model.

Effect of Case Volume on Operating Room Time and Complications

There was evidence of increased operating room efficiency, because the operating surgeon gained experienced with the modified gift-box technique. Specifically, there was a linear relationship between operating room time and the number of cases performed by the operating surgeon using the modified gift-box technique ($r = 0.46$, $p \leq .001$) (Fig. 6). There was no evidence of a floor in operating room time with later cases in the series, indicating that the "learning curve" for this particular technique in terms of operating room efficiency may extend beyond 60 cases.

There was no relationship between case volume and complication rates. The first 30 cases included 2 (6.7%) complications, and the second 30 cases also included 2 (6.7%) complications ($p = 1.0$). The 1 secondary rupture that required a second repair occurred late in the series at case no. 57.

Discussion

The results of this Achilles repair case series compare favorably with the data reported previously. The Achilles tendon rerupture rate following nonsurgical treatment is as high as 10% to 12%. Surgery, conversely, lowers the rate to less than 3% (18). Excluding rerupture, complications following operative repair have been reported as high as 27% (4,19). Our reported rate of adverse outcomes is low, with rerupture and wound complication rates of 1.7% each. However, it is worth noting that much of the previous literature has a follow-up extending >1 year, and thus, the possibility of our rerupture rate increasing with an extended follow-up should be acknowledged. The mean force to failure for the gift-box technique has been reported at 168 Newtons (1), which is nearly twice the strength of the traditional Krackow technique, but less than the 453 Newton strength of the triple bundle technique (13,15). The concern with techniques such as the triple-bundle techniques is the large burden of suture placed in the hypovascular zone of the tissue, which may inhibit healing and contribute to a higher rerupture rate (13). It is the opinion of the authors that these early data suggest that the modified gift-box technique with suture loop is an acceptable alternative to the gift-box technique described originally (1), which achieves adequate tensile strength and minimizes suture burden in the hypovascular zone, both of which likely contribute to decreased rerupture rates. However, further biomechanical analysis specifically examining the modified gift-box suture loop technique would be useful.

The secondary rupture that occurred in this series was in a 27-year-old male who sustained the original injury while playing basketball. At 5 months postoperatively, he returned to the clinic, stating a lack of progress in physical therapy and the sensation of 2 to 3 "pops" in his ankle or tendon, which he had experienced without a traumatic or sport injury mechanism. The suspicion of a secondary rupture was confirmed with magnetic resonance imaging, and he subsequently elected to undergo a revision procedure. In addition, 1 patient in this series did require return to the operating room for lysis of adhesions and

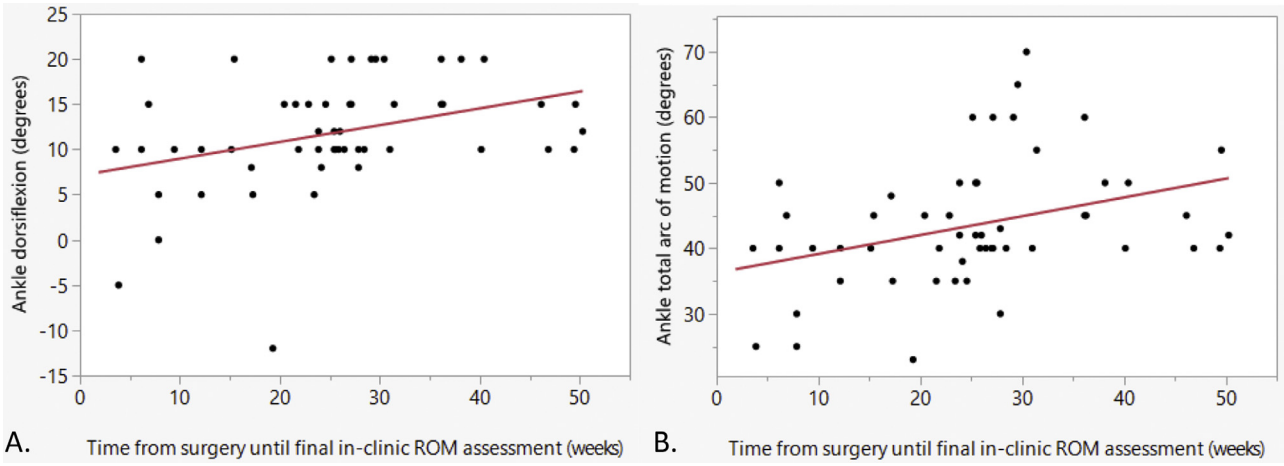

Fig. 5. Scatterplot of (*A*) postoperative ankle dorsiflexion and (*B*) total arc of motion, versus time from surgery until the final in-office range-of-motion (ROM) assessment. There is a positive association between the increased length of follow-up and greater dorsiflexion (mean 0.2° per week, $r = 0.36$, $p = .008$), as well as a greater total arc of motion (0.3° per week, $r = .36$, $p = .007$). Time from surgery to ROM assessment was not associated with plantarflexion ROM ($r = .20$, $p = .16$).

debridement at the 10-month postoperative mark. He was considered to have scar formation at the incision, which was limiting his plantarflexion, despite conservative management with physical therapy, scar massage, and continued strengthening.

Perhaps not surprisingly, those patients with a longer length of in-office follow-up continued to show a trend toward improvements in the range of motion. This was particularly true in both dorsiflexion and total arc of motion. Knowing that patients in this study were immobilized in plantarflexion postoperatively, consistent with the standard of care, it would seem logical that dorsiflexion and thus total arc of motion continue to improve for an extended time following surgery. Our data seem to support this but did not achieve statistical significance.

With regard to functional scores at 1 year, diabetic patients did have statistically lower outcomes. This was found to be the only significant predictor in our data following multivariate analysis. Prior data demonstrate that although diabetes is an independent risk factor for infection (20), diabetic patients can still do well, with a reported ATRS of 70.4 ± 13 points at the 4-year postoperative mark following percutaneous repair (7). Qualitatively, this is a higher or better mean score than that reported in our series (mean ATRS 51.5 ± 4.9 points). Perhaps, the better functional outcome achieved in the prior study could be attributed to both the longer length of follow-up time and the difference in the technique, using a percutaneous rather than open approach. This would seem to suggest that diabetic patients experience better outcomes with percutaneous repair and that their recovery is slowed compared to non-diabetic patients. Special consideration should be given to this population before proceeding with open repair.

Table 4
Independent effect of patient age, diabetes status, tobacco use, and insurance status on Achilles tendon rupture score at 1 year (N = 59)

Predictor	Estimated Effect on ATRS	*p* Value*
Diabetes (no)	NA (referent)	.03
Diabetes (yes)	−13.5 ± 6.0 points	
Insured	NA (referent)	.19
Uninsured	−4.3 ± 3.3 points	
Never smoked	NA (referent)	.66
Positive tobacco use history	−1.4 ± 3.1 points	
Patient age, y	Per year: + 0.05 ± 0.23 points	.84

Data presented as mean ± standard deviation, unless otherwise noted.
Abbreviations: ATRS, Achilles tendon rupture score; NA, not applicable.
* F test for each effect in multivariate linear regression model.

We hypothesized that this technique would be more efficient and have a shortened duration of surgery compared to previous techniques. There are surprisingly few data examining the operative times, and those that do exist are quite ambiguous in how the length of surgery is measured. Furthermore, studies of this nature are not without inherent bias owing to the surgeon's speed, ability, and familiarity with the technique. This is evidenced in our data, because there was a clear learning curve and decrease in the length of surgery as the operating surgeon became more experienced and familiar with the technique (Fig. 6). Interestingly, the downward trend was still occurring at the end of the study, suggesting that further improvement may still be made beyond 60 cases. However, perhaps more importantly, there was no difference in complication rates between the surgeries performed early in the series and those performed late in the series. This would suggest that surgeons were able to attempt this novel modified gift-box suture loop technique without additional risk or detriment to patient outcomes. It is the opinion of the authors that this technique can be performed more efficiently than the standard Krackow repair with or without the

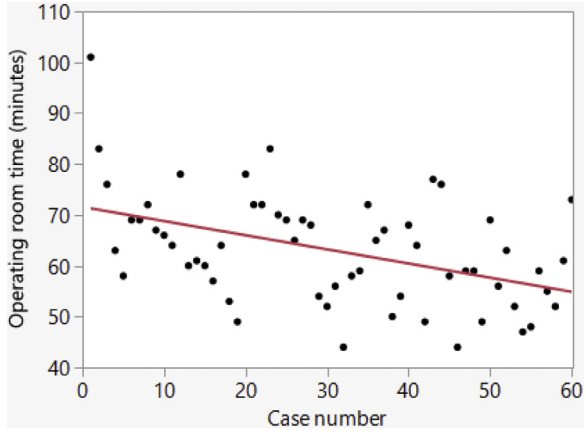

Fig. 6. Scatterplot of the length of surgery in minutes versus the number of cases performed by the operating surgeon by using the modified gift-box technique. There is evidence of continual improvement in surgical efficiency throughout the case series. Specifically, there is a linear association between the surgery date and the decreased surgery length ($r = 0.46$, $p < .001$), without an obvious floor in surgical times in the later cases in the series.

gift-box technique, thus shortening the operative time and decreasing all the inherit risks associated with open surgical intervention; however, further research is needed to prove this claim.

This study has several limitations. As a consecutive case series, there is no control group or direct comparison made between other repair techniques. The safety and efficacy of this technique for the repair of chronic ruptures are unknown. The mean time to surgery was 14.7 days (maximum 70 days), and the low complication and rerupture rates reported in this series may not apply to chronic repairs. There is limited evidence that chronic and acute repairs can have similar functional outcomes (21), but chronic repairs may have higher rates of complications such as venous thromboembolism compared with acute repairs (22). Similarly, no direct comparison has been made with a group of patients managed nonoperatively or with a group of patients managed with other operative techniques. Previously published data were used as the control group for comparisons in the study. In addition, not all patients experienced the same length of clinical follow-up, because there was variability in whether patients would return for clinical visits past the 6-month point or, more frequently, if postoperative concerns were encountered. Furthermore, the ATRSs were not collected at every interval postoperative visit, so this study was unable to analyze how these progressed over designated time intervals.

The strengths of this study include the consistency of the design, with all operations being performed by a single surgeon at a single institution in a consecutive series. The study was adequately powered to determine the complication rates and functional outcome scores within a reasonable degree of certainty. In addition, we were able to obtain complete 1-year follow-up data on nearly 84% of the patients undergoing the procedure. Furthermore, use of the ATRS is an excellent metric of patient-reported outcomes and has been found to have high reliability, validity, and sensitivity for measuring the function specific to Achilles rupture (6,16).

In conclusion, the short-term outcomes for this novel technique are comparable with previously reported Achilles repair procedures. The rerupture and overall complication rates by 1 year were low, with range of motion, particularly dorsiflexion, improving through at least 6 months. Diabetic patients had lower 1-year ATRS scores than nondiabetic patients using this technique.

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