

Primary repair for injury of medial collateral ligament during total-knee arthroplasty

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Abstract

The aim of this study was to determine whether primary repair for intraoperative injury of the medial collateral ligament (MCL) can achieve satisfactory clinical results when compared to the clinical results of patients with no MCL injury. Simultaneously, we sought to determine the differences between 2 methods of primary repair (anchor suture and staple) in terms of their clinical outcomes.

In our institute, 3897 total-knee arthroplasties (TKAs) were performed between 2003 and 2014. Sixty-five patients who suffered an MCL injury during the TKA procedure and in whom the injury was repaired with a suture anchor or staple (suture anchor: 36 vs staple: 29) were studied. A matched group of 65 patients without an MCL injury was selected to serve as the control group. Subjective feelings of instability and functional outcomes were assessed using the knee society (KS) score and the Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC). Objective stability was evaluated by the measurement of opening angles in extension and at 30° of knee flexion on valgus stress radiographs. The clinical outcomes and stability results were compared between the suture anchor and staple methods.

The KS and WOMAC scores in patients who received primary repair of MCL injury during TKA improved from 50.6 ± 13.1 to 87.3 ± 7.3 ($P < .001$) and 65.9 ± 14.4 to 17.7 ± 6.6 ($P < .001$), respectively. However, there were no statistically significant differences in the KS ($P = .84$) and WOMAC ($P = .71$) scores when comparing the group that received primary repair to the control group. Radiographic stability also showed no differences between the repair and control groups in extension and at 30° of flexion ($P = .48$ and $P = .11$, respectively). In the subgroups, there were no significant differences between the suture anchor and staple repair methods in terms of stability and clinical outcomes.

Primary repair of an MCL injury during TKA may have clinical outcomes comparable to that in the no MCL injury group. Both staple and suture anchor repair methods could provide excellent clinical and stability outcomes in these types of cases, although a further cohort study is required to validate our results.

Abbreviations: KS = knee society, MCL = medial collateral ligament, ROM = range of motion, TKA = total-knee arthroplasty, WOMAC = Western Ontario & McMaster Universities Osteoarthritis Index.

Keywords: injury, medial collateral ligament, staple, suture anchor, total-knee arthroplasty

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1. Introduction

Soft-tissue balancing is one of the most important determinant factors for a successful primary total-knee arthroplasty (TKA) as it governs coronal (varus-valgus) and rotational stability of the knee after TKA.^[1–5] In general, knees that suffer from degenerative osteoarthritis with varus deformity need proper medial soft-tissue release.^[6] However, there are some cases reported in which injury to the medial collateral ligament (MCL) occurred due to over-release when medial release was performed to obtain mediolateral balance during TKA. As the MCL is important in maintaining coronal plane stability and resisting valgus stress, its preservation can improve the function and longevity of a knee prosthesis.^[7,8] If the injury to the MCL is not recognized and addressed immediately, it may lead to increased medial instability, early failure of the implant, and may require subsequent interventions that can be avoided if it is treated appropriately initially.^[9]

Currently, several options are available for the treatment of over-release injury of the MCL, including conservative management with a brace and surgical methods with the use of a constrained prosthesis. Alternatively, primary repair could be used for augmentation of the MCL.^[9–14] However, differing opinions exist on the matter of the choice of method for managing an MCL injury, and there is no gold standard for the

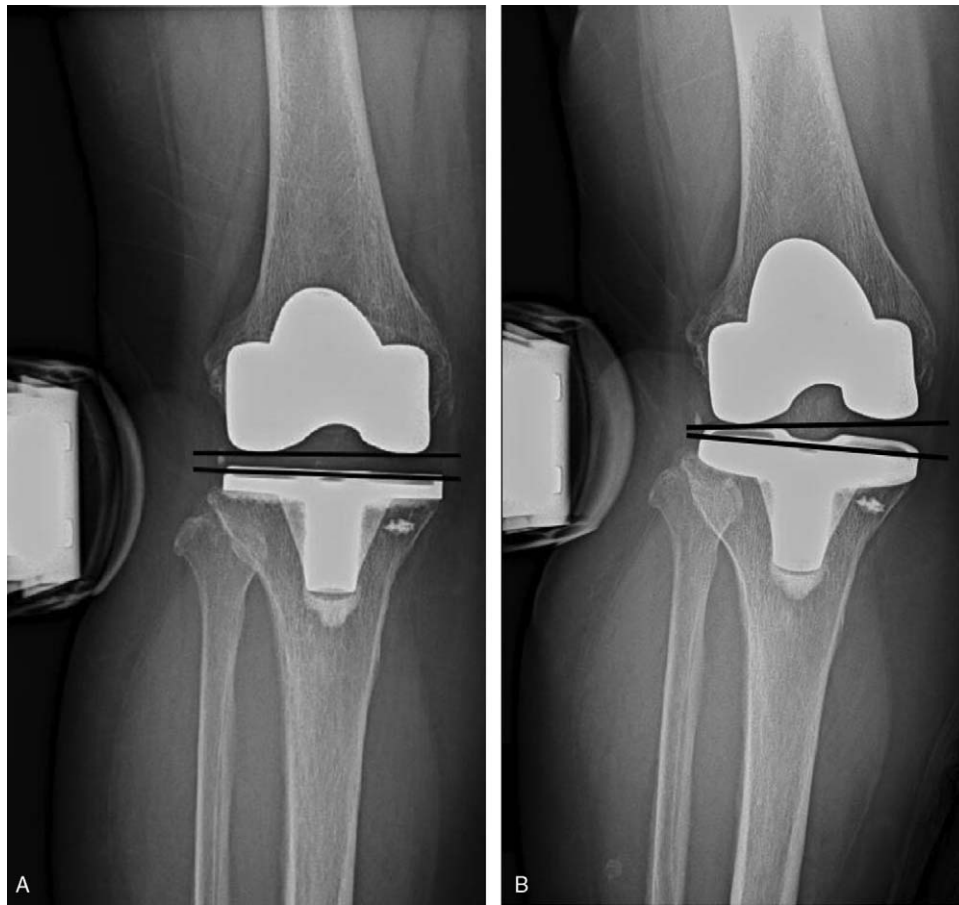


Figure 1. Measurements of medial opening angles on valgus stress radiographs. (A) At full-knee joint extension. (B) At 30° of knee joint flexion.

management of iatrogenic injury of the MCL during TKA.^[15–21] Furthermore, studies regarding the primary repair of MCL injury are scarce.

In this study, we aimed to determine whether primary repair of MCL injury can achieve satisfactory clinical results in comparison to the clinical results of an un-injured group. Simultaneously, we sought to determine the differences between 2 methods of primary repair (anchor suture and staple) in terms of their clinical outcomes to determine which method would provide a better outcome for the patients.

2. Materials and methods

This was a single tertiary center, retrospective, observational study conducted with the approval of the institutional review board. Informed consent was obtained from all participating patients. We reviewed a total of 3897 TKA procedures that were performed for grade IV gonarthrosis in the period between January 2003 and June 2014. Patients who suffered intraoperative injury of the MCL and who were treated with primary repair using either the suture anchor or staple method were included in the study. We excluded patients with MCL injury at the mid-substance or avulsion from the femoral origin as our aim was to study the results of MCL injury at the tibial insertion. A total of 68 cases were identified. Three patients were excluded from the study, as they were lost to follow-up. Thus, 65 patients (suture anchor: 36; staple: 29) eligible for the study were finally

assessed. Simultaneously, a matched group of 65 cases in which no MCL injury occurred was reviewed as a control group.

For each patient, basic sociodemographic data and other relevant data such as age, sex, and body mass index (BMI) were collected.

We measured the subjective feelings of instability and functional outcomes based on the knee society (KS) score and the Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC). Objective quantitative instability was evaluated by measurement of the opening angle in a valgus stress radiograph obtained using the Telos device (Telos stress device; Austin & Associates, Fallston, MD) under 150N (Fig. 1). The data collected during the final follow-up were then compared between groups; those who had suffered an intraoperative MCL injury compared to the control group, and those who had received suture anchor repair compared to those who had received the staple method of repair.

2.1. Surgical technique

The TKA surgeries in all patients were performed using a standard surgical technique and postoperative protocol. All surgery was performed by a single senior surgeon (EKS). All surgeries employed the use of the medial parapatellar approach with tourniquet application in the supine position. During the operation, all patients underwent a routine preanesthetic check-up. A prophylactic dose of 1g cefazolin was administered

preoperatively in both groups. Tibial cutting was performed perpendicular to the mechanical axis of the tibia with a 3° posterior slope using an extramedullary guide in both groups. Subsequently, the distal femoral cut was performed using an intramedullary guide with approximately 4° to 6° of valgus based on the difference between the anatomical and mechanical axes of the femur. The removal of osteophytes and adequate medial soft-tissue release were performed to achieve mediolateral balance in extension with no more than 2 mm of difference. Following this, the resection line for the femoral component was drawn on the cut surface of the distal femur, parallel to the resected proximal tibia at 90° of knee flexion with distraction using a laminar spreader with tension. The posterior and chamfer cuttings were performed after positioning the 4 in 1 cutting blocks. All prostheses were of the posterior stabilized type. Mediolateral balance within 2mm, as measured using the varus and valgus stress tests, was achieved by MCL release. Then complete detachment of the MCL at tibial attachment was examined. If complete detachment of the MCL with opening of more than 5 mm in extension or at 30° of knee flexion under valgus stress test was noted, the site of tibial detachment was fixed with either a suture anchor or staple to provide additional stability.^[10] After assessing stability and patellar tracking, the arthrotomy was closed and surgical drains were put in place in all cases.

All patients were managed with a similar postoperative rehabilitation protocol. The drain was removed 48 hours following surgery. In the MCL injury group, early inpatient physiotherapy and range of motion (ROM) exercises were initiated while the patient was in a knee brace. The patient's knee was protected with a brace for 4 weeks following the operation.

2.2. Statistical analysis

All data were presented as the mean and range. Statistical analyses were performed using the SPSS statistical software system version 21.0 (SPSS, Chicago, IL). Kolmogorov–Smirnov tests were performed to evaluate whether the data showed a normal distribution or not. For the data with a normal distribution, a Student paired *t* test was performed to compare outcomes between groups preoperatively, and at the final follow-up, an independent *t* test was performed for comparison of outcomes between the 2 groups. For the data showing a nonnormal distribution, Mann–Whitney *U* tests were employed for the comparison of outcomes measured preoperatively and at the final follow-up, and between the 2 groups. A significance level of *P* < .05 was assumed for all statistical tests. To detect a difference between the repair and control groups in total stability (based on stress radiograph) of 2° (standard deviation, 2.5), power analysis determined that a total of 25 patients were required per group (power = 0.8 and α = 0.05).

3. Results

Of the 3897 TKA procedures performed for grade IV varus gonarthrosis during the study period, 68 (1.75%) were complicated with intraoperative over-release injury of the MCL. However, only 65 patients were eligible for this study. The study population consisted mainly of females (91% females, 9% males). The mean age was 71.4 years old (range, 58–83 years old), and the mean BMI was 26.4 kg/m² (range, 20.2–35.1 kg/m²). The mean preoperative mechanical axis was varus 12.1°

(range, 3.1–20.5°). The average preoperative ROM was 117.4° (range, 75–140°). The mean duration of postoperative follow-up was 74 months (range, 26–125 months).

3.1. Comparison between MCL injury and control groups

Preoperatively, the group with an MCL injury and the control group were comparable in all preoperative demographics. All measured alignment axes were improved significantly at the final follow-up examination for both MCL injured and control groups compared with the preoperative values (*P* < .001, Table 1). However, there were no significant differences between groups at the final follow-up (*P* = .19, Table 1). The stability in extension, as measured by stress radiographs, was 3.7 ± 1.5° in the MCL-injured group and 3.9 ± 2.1° in the control group. The difference was not statistically significant (*P* = .48). There also was no significant difference between the 2 groups in stability at 30° of knee flexion (*P* = .11). At the time of the final follow-up, no patient complained of instability of the knee and all patients were capable of community ambulation without any assistive device. The KS and WOMAC scores also showed improvements in both groups (KS: 87.3 in the MCL-injury group and 87.6 in the control group, *P* < .001; WOMAC: 17.7 in the MCL-injury group and 17.1 in the control group, *P* < .001). However, the KS and WOMAC scores were not statistically significantly different between the groups at the final follow-up (*P* = .84 and *P* = .71, respectively). There was a significant improvement in ROM at the final follow-up (125.6° in the MCL-injury group and 128.1° in the control group, *P* < .001) with no intergroup difference at the final follow-up (*P* = .09).

Table 1
Clinical outcomes and stability of MCL repair group and control group.

Variable	Repair group n = 65	Control group n = 65	P-value
Age, yr	71.4 ± 7.8	69.2 ± 7.3	.101
Body mass index, kg/m ²	26.4 ± 3.6	26.2 ± 3.7	.714
Follow-up, mo	74.1 ± 29.6	79.8 ± 28.7	.262
MA, degree			
Preoperative*	-12.1 ± 4.5	-10.8 ± 4.3	.109
Last follow-up	-0.9 ± 2.2	-1.3 ± 1.9	.188
P-value	<i>P</i> < .001	<i>P</i> < .001	
Range of motion, degree			
Preoperative*	117.4 ± 18	120.9 ± 14	.219
Last follow-up*	125.6 ± 8.9	128.1 ± 8.1	.098
P-value	< .001	< .001	
KS score, points			
Preoperative	50.6 ± 13.1	54.8 ± 11.7	.051
Last follow-up*	87.3 ± 7.3	87.6 ± 10.1	.843
P-value	< .001	< .001	
WOMAC score, points			
Preoperative	65.9 ± 14.4	64.6 ± 15.2	.607
Last follow-up*	17.7 ± 6.6	17.1 ± 9.8	.714
P-value	< .001	< .001	
Stability, degree			
Last follow-up			
Extension*	3.7 ± 1.5	3.9 ± 2.1	.484
30° Flexion	5.5 ± 2.1	4.9 ± 2.4	.106

KSα = knee society, MAα = mechanical axis (-varus), WOMACα = Western Ontario & McMaster Universities Osteoarthritis Index.
* Mann-Whitney *U* test.

Table 2
Clinical outcomes and stability of suture anchor vs staple as mode of repair.

	Suture anchor n=36	Staple n=29	P-value
Age, yr	70.9±7.1	71.8±5.8	.525
Body mass index, kg/m ²	26.3±3.4	26.6±3.9	.781
Follow-up, mo	69.8±27.6	78.9±32.4	.318
MA, degree			
Preoperative*	-11.9±4.6	-12.2±4.4	.788
Last follow-up	-1.1±2.4	-0.6±1.9	.422
P-value	<.001	<.001	
Range of motion, degree			
Preoperative*	119.6±17.1	115.7±17.4	.287
Last follow-up*	125.6±8.5	125.9±9.5	.774
P-value	.031	.003	
KS score, points			
Preoperative	51.9±12.4	48.9±17.1	.463
Last follow-up*	86.4±7.2	88.3±7.5	.379
P-value	<.001	<.001	
WOMAC score, points			
Preoperative	62.8±15.2	69.9±16.5	.143
Last follow-up*	18.3±5.6	16.3±8.1	.077
P-value	<.001	<.001	
Stability, degree			
Last follow-up			
Extension*	4.1±2.6	3.1±2.2	.058
30° flexion*	6.2±2.3	4.8±1.4	.201

KSα=knee society, MAα=mechanical axis (-:varus), WOMACα=Western Ontario & McMaster Universities Osteoarthritis Index.

* Mann-Whitney U test.

3.2. Comparison between suture anchor and staple groups

With respect to the MCL repair methods, suture anchor and staple, baseline demographics of both groups of patients were statistically similar (Table 2). The functional outcomes of the surgery (KS and WOMAC scores) were significantly improved (KS to 86.4 [$P<.001$] and 88.3 [$P<.001$], WOMAC to 18.3 [$P<.001$], and 16.3 [$P<.001$] in the suture anchor and staple groups, respectively). However, we could not identify any difference between the 2 groups at the final follow-up ($P=.38$ in KS and $P=.08$ in WOMAC). Moreover, stability in extension and at 30° of knee flexion were not statistically significantly different between the suture anchor group and the staple group ($P=.06$ and $P=.20$, respectively).

4. Discussion

Intraoperative injury of the MCL is not an uncommon complication yet its recognition and immediate treatment is crucial for the prevention of undesirable outcomes.^[7,8,11-14,22] In this study, we found that the primary repair of MCL injury using either an anchor or a staple during TKA provided comparable clinical outcomes and stabilities as in a noninjured group.

Previous studies by Leopold et al^[10] and Bohl et al^[13] reported good to excellent clinical outcomes of the primary repair of injured MCL during TKA. Unfortunately, no control group was included in their studies. Both of these previous studies also included mixed cases of mid-substance and avulsion injury, which may have biased the conclusion. Our study focused on the outcome of primary repair (suture anchor

or staple) for tibial insertion MCL injury during primary TKA for varus gonarthrosis. At the final follow-up, the MCL injury group showed similar improvements in terms of objective and subjective outcomes as compared to that in the noninjured group. We also found that the groups did not show significant differences in final alignment, range of joint motion, joint stability, and functional outcome according to the KS and WOMAC scores.

In this study, we tried to objectively measure medial coronal stability by means of a stress radiograph with the Telos device. Although there were no differences in valgus stability between the MCL injury and control groups at extension and 30° knee flexion, the difference between the groups was slightly greater at 30° knee flexion (0.6° vs 0.2°), despite the lack of statistical significance. For comparison, Koo and Choi^[23] previously reported the outcome of conservative treatment for MCL tibial insertion site injury during TKA. They found a mean difference of 1° greater valgus laxity (standing position) in the MCL injury group than in the non-MCL injury group (4° vs 3°). However, they evaluated and compared the valgus laxity only in extension, not at 30° knee flexion, which is a more important angle for the evaluation of MCL stability.

The primary repair of MCL injury with staples vs suture anchor was compared in terms of the functional outcomes and stability. The use of a suture anchor or staple for repair of an MCL injury during TKA has previously been reported by several authors.^[10,11,13,24] However, to our knowledge, no previous study has reported a comparison between the 2 methods. Although the stress radiographs showed that the suture anchor group had a larger valgus laxity by 1° in extension and by 1.4° at 30° knee flexion compared to the staples group, the differences were not statistically significant. Furthermore, the final clinical outcomes of the 2 groups were comparable. For comparison, White et al^[25] reported the use of bone staple for reapproximation for superficial MCL avulsion from the tibial attachment during primary TKA. In our study, no patients who received a staple repair required revision surgery for instability in the mean follow-up period of 2.6 years. However, subjective instability was reported in 19.2% in the staple repair group in contrast to the 24.2% in the control group.

4.1. Limitations

There were several limitations to this study. Firstly, this study was conducted retrospectively with a relatively small number of patients. A low patient number renders the study prone to inherent biases, which a prospective randomized study would not have. Secondly, some variability in the degree of deformity and ligament degenerative laxity may pose some bias, although all cases included were of grade IV varus gonarthrosis. Thirdly, the power for comparison of outcomes between the staple and suture anchor groups might not be sufficient for drawing definitive conclusions. Moreover, we did not have a control group that received conservative treatment for the MCL injury. Therefore, to validate our results, a further cohort study to compare primary repair with conservative treatment for injured MCL during TKA and that with a larger number of patients for comparison between the staple and suture anchor methods is warranted.

5. Conclusion

Primary repair of MCL injury during TKA for varus gonarthrosis can lead to clinical outcomes comparable to that observed in

patients with no MCL. Both the staple and suture anchor methods could be reliable options of repair method in these types of cases, although a further cohort study is required to validate this result.

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