

Original Article

Medial collateral ligament reattachment during total knee arthroplasty for the management of knee osteoarthritis: procedural safety and surgical effects

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Abstract: Objective: To evaluate the procedural safety and surgical effects of medial collateral ligament (MCL) reattachment during total knee arthroplasty (TKA) in patients with knee osteoarthritis (KOA). Methods: A total of 109 patients with KOA who underwent TKA at the Second Hospital of Lanzhou University between February 2024 and February 2025 were included. Patients were divided into two groups according to the surgical technique used: a control group (n=50, routine surgery) and a research group (n=59, MCL reattachment). The following outcomes were compared between the two groups: operation-related incises, procedural safety, postoperative recovery, postoperative pain assessed using the visual analogue scale (VAS), knee range of motion and function assessed using the Hospital for Special Surgery (HSS) Knee Scoring System, inflammatory markers, stress-related indicators, and bone metabolism markers. Results: No significant differences were observed between the two groups in operation-related indices, procedural safety, or postoperative recovery. On postoperative day 3, VAS scores for pain at rest and during movement, inflammatory markers, and stress-related indicators were significantly lower in the research group than in the control group. The research group exhibited significantly greater knee range of motion and higher HSS scores at 6 and 12 months postoperatively, as well as notably higher bone metabolism incises at 6 months postoperatively. Conclusion: MCL reattachment during TKA is a sage surgical technique for patients with KOA and can reduce surgical stress while improving postoperative knee mobility and function.

Keywords: Medial collateral ligament reattachment technique, total knee arthroplasty, knee osteoarthritis, procedural safety, surgical stress

Introduction

Knee osteoarthritis (KOA), a common orthopedic joint disorder, is pathologically characterized by progressive degeneration and loss of articular cartilage, accompanied by structural and functional alterations of the joint [1]. The pathologic changes involve not only the articular cartilage but also the synovium, joint capsule, and periarticular muscles, ultimately causing irreversible joint damage [2]. Clinically, KOA primarily manifests as arthralgia, especially during joint movement, as well as relatively brief and self-limiting morning stiffness [3]. Total knee arthroplasty (TKA), a commonly performed surgical procedure, can improve physical function and relieve pain in patients with advanced KOA [4]. More than 700,000 TKA

procedures are performed annually in the United States alone; however, about 30% of patients experience suboptimal postoperative outcomes [5].

The medial collateral ligament (MCL) is a critical medial soft-tissue structure of the knee. Excessive intraoperative release at its tibial attachment can induce local inflammation and surgical stress, leading to early postoperative pain of the medial tibia and limiting early functional rehabilitation [6]. Additionally, improper management of MCL injury can cause knee instability, accelerated prosthetic wear, pain, and poor functional outcomes, thereby compromising procedural safety [7]. The MCL reattachment technique involves complete subperiosteal detachment of the MCL complex and

marking of its insertion site. Then, two to three bone tunnels are drilled at the tibial insertion site, through which the MCL complex is reattached to its original position using #1 non-absorbable sutures [8]. This technique may enhance medial stability, alleviate pain, and improve knee function. However, it may also increase surgical complexity and prolong operation time (OT), while the fixation achieved through suturing and knot tying may depend on the surgeon's experience and precise positioning of the bone tunnels [9]. At present, research on MCL reattachment technology remains limited, and the available evidence has focused primarily on biomechanical comparisons. By contrast, MCL reconstruction technique, which typically uses grafts to restore ligament continuity, is more suitable for patients undergoing revision TKA surgery than for those undergoing primary TKA [10].

To ensure procedural safety of TKA and reduce surgical stress in patients with KOA, the intraoperative management of the MCL warrants further optimization. The purpose of this study was to evaluate the procedural safety and surgical effects of MCL reattachment during TKA in KOA patients, thereby providing additional evidence to guide the selection of surgical techniques.

Materials and methods

General information

A total of 109 patients with KOA who underwent TKA at the Second Hospital of Lanzhou University between February 2024 and February 2025 were retrospectively included in study. Patients were divided into two groups according to the surgical technique used: a control group (n=50) that received routine surgery, and a research group (n=59) managed with the MCL reattachment. The baseline characteristics were comparable between the two groups ($P>0.05$). This study was approved by the Ethics Committee of the Second Hospital of Lanzhou University.

Patient enrollment criteria

Inclusion criteria: diagnosis of end-stage KOA after presenting with knee joint pain [11]; unilateral disease; first-time receipt of TKA; absence of contraindications to anesthesia; normal communication ability; no use of medica-

tions that may affect the study outcomes within the preceding 6 months; and availability of complete clinical data.

Exclusion criteria: a history of knee joint injury; other types of arthritis; autoimmune diseases (e.g., rheumatoid arthritis, ankylosing spondylitis); neurological disorders, such as Charcot neuroarthropathy; lower-extremity neuromuscular diseases or other conditions that may interfere with postoperative functional rehabilitation; severe osteoporosis; systemic diseases resulting in surgical intolerance; pre-existing contraindications to surgery, such as blood pressure $>150/90$ mmHg or blood sugar >7.0 mmol/L; coagulation disorders; concurrent malignancy, major organ dysfunction, or infectious diseases; psychiatric disorders; and pregnancy or lactation.

Treatment methods

The MCL reattachment technique was used in the research group. All procedures were performed by the same surgical team. A posterior-stabilized knee prosthesis (Weigao Group) was used without patellar resurfacing. After induction of general anesthesia, each patient was placed in the supine position. A medial parapatellar approach was adopted, with an approximately 10-cm incision, followed by sequential dissection of the skin and subcutaneous tissues. The articular capsule and extensor mechanism were incised along the medial border of the patella, and the hyperplastic synovium and osteophytes were removed. Following transection of the anterior and posterior cruciate ligaments, the tibia was displaced anteriorly to facilitate removal of the remaining meniscal tissue. Meanwhile, the soft tissue 1 cm beneath the articular surface was released, and the MCL complex was completely elevated subperiosteally, and its insertion site was marked.

A distal femoral osteotomy was performed at 6° of valgus. The proximal tibia osteotomy was made perpendicular to the mechanical axis, with a posterior slope of 3° . The anterior and posterior femoral condylar cuts were made with 3° of external rotation. Femoral and tibial trial components of appropriate sizes were selected using sizing guides and inserted. After reduction, lower-limb mechanical alignment and rotational alignment were assessed. Tibial pad thickness was selected according to soft-tissue tension. After confirming knee joint stability

and satisfactory patellar tracking, the trial components were removed, and 2-3 bone tunnels were drilled at the tibial insertion site of the MCL. While the bone cement was being prepared, the definitive tibial and femoral prostheses were placed, and then the knee joint was maintained in extension until the bone cement had fully polymerized.

The MCL complex was reattached to its original insertion site through the bone tunnels using #1 nonabsorbable sutures. The sutures were passed through the bone tunnels, and the knots were tied and secured over the medial tibia cortex. Patellar denervation was performed, and peripatellar osteophytes were removed. The joint cavity was irrigated, and a drainage tube was placed adjacent to the medial incision. Postoperatively, patients wore an unlocked hinged knee brace for 6 weeks, allowing a range of motion (ROM) of 0°-90°.

Patients in the control group underwent conventional TKA. The MCL complex was completely preserved without additional intervention, and only the medial soft tissues were sutured to the medial border of the patellar tendon. After prosthesis implantation, the incision was sutured in layers, a drainage tube was placed, and a sterile dressing was applied.

After the surgery, all patients routinely received prophylactic antibiotics, anticoagulants, and medications for circulation-promoting purpose. Crystalloid and colloid solutions were administered according to the intraoperative blood loss (IBL). The infusion speed was controlled to avoid excessive cardiac load. Multi-modal nonopioid analgesia comprising acetaminophen and nonsteroidal anti-inflammatory drugs (NSAIDs) were administered, with weak opioids added if indicated.

Isometric quadriceps contraction and ankle pump exercises were initiated on postoperative day 1 and performed in four sets of 20 repetitions per day. On postoperative day 2, straight leg-lifting exercises were added (4 sets/day × 15 repetitions/set). Assisted ambulation with a walker was initiated on postoperative day 3; patients in the study group wore a knee brace during ambulation. Blood routine, biochemistry tests, C-reactive protein (CRP), and erythrocyte sedimentation rate were assessed on postoperative days 1, 3, and 7. Blood transfusion and

albumin supplementation were administered if clinically indicated.

The drainage tube was removed when the drainage volume was <50 mL within the latest 48 h. Wound secretions collected for microbiological cultures. According to the results of antimicrobial susceptibility testing and laboratory testing of infection indices, the type and dosage of antibiotics were adjusted. Vigilant postoperative observation of the incision was also ensured, and dressings were changed promptly in cases of exudation. Once the patient's condition had stabilized, routine dressing changes were performed every 2-3 days, and sutures were removed two weeks after the operation. Standard prophylactic measures against lower-extremity deep venous thrombosis (DVT) were implemented. Patients were guided to do appropriate functional exercises and were instructed to attend regular outpatient follow-up visits for assessment of postoperative recovery.

Outcome measures

Perioperative incises: OT, IBL, and postoperative drainage volume were recorded.

Procedural safety: The numbers and percentages of patients who experienced MCL re-rupture, periprosthetic infection, or DVT within one year after operation were recorded, as well as the revision rate.

Postoperative recovery: Postoperative recovery was assessed according to the decrease in hemoglobin (Hb) level on postoperative day 3, time to achieve active knee flexion of 90°, and length of hospital stays.

Postoperative pain [12]: Pain intensity, both pain at rest and movement-evoked pain (MEP), were assessed using a 10-point Visual Analogue Scale (VAS) before and 3 days after the operation. Higher scores indicated greater pain intensity.

Knee joint mobility and function: Knee joint ROM was measured using the Neutral-0 method before surgery and at 6 and 12 months postoperatively. The neutral position was defined as 0°, and the reference range was 0°-130°. Knee joint function was evaluated at the same time points using the Hospital for Special Surgery (HSS) Knee Scoring System [13]. The scale assesses pain, function, ROM, muscle strength, knee flexion deformity, and

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Table 1. Comparison of baseline characteristics between the two groups

Variable	Control group (n=50)	Research group (n=59)	t/ χ^2	P
Age (years)	61.94±7.93	62.31±8.12	0.240	0.811
Body mass index (kg/m ²)	23.36±2.31	23.19±2.41	0.374	0.709
Disease course (years)	7.36±2.71	7.08±2.20	0.595	0.553
Sex			0.130	0.718
Male	22 (44.00)	28 (47.46)		
Female	28 (56.00)	31 (52.54)		
Affected knee			0.155	0.693
Left	21 (42.00)	27 (45.76)		
Right	29 (58.00)	32 (54.24)		
American Society of Anesthesiologists grading			0.326	0.568
Grade I	29 (58.00)	31 (52.54)		
Grade II	21 (42.00)	28 (47.46)		

knee stability, with a maximum score of 100. Higher scores indicate better knee function.

Inflammatory makers: Venous blood samples (3 mL) were collected before surgery and 3 days after surgery. After centrifugation for 10 minutes, the serum was separated and stored at -80°C until analysis. Serum tumor necrosis factor (TNF)- α , CRP, and interleukin (IL)-6 levels were quantified using the enzyme-linked immunosorbent assay (ELISA), with corresponding ELISA kits purchased from Abbkine (Wuhan) Scientific Co., Ltd. (KTE6032, KTE6004-3, KTE6017).

Stress markers: Before surgery and on postoperative day 3, serum levels of norepinephrine (NE) and cortisol (Cor) were measured using ELISA, with kits obtained from Wuhan Elab-science Biotechnology Co., Ltd. (E-EL-0047, E-OSEL-H0006).

Bone metabolism markers: Serum osteocalcin (BGP), calcitonin (CT), and osteoprotegerin (OPG) levels were measured by ELISA at baseline and 6 months after surgery. The corresponding human ELISA kits were purchased from Shanghai Fusheng Industrial Co., Ltd. (A127070, A127160, A127066).

Statistical analysis

Normality and homogeneity of variance were tested on all continuous variables using the Shapiro-Wilk test and Levene's test, respectively. If both conditions were met, continuous data were presented as means $\pm$ standard deviations and compared between groups using the

independent-samples *t*-test and within groups using the paired-samples *t*-test. The median (interquartile range) was used for statistical description in cases of skewed distributions or unequal variances; in these cases, the Mann-Whitney U test was used for between-group comparisons and the Wilcoxon signed-rank test for within-group comparisons. Categorical variables were presented as numbers and percentages [n (%)] and compared between groups using the chi-square (χ^2) test. For repeated measures data at multiple time points, the main effects of time, group, and time $\times$ group interaction were evaluated by repeated measures analysis of variance. The uncorrected results were used directly if the sphericity assumption was satisfied, and the Greenhouse-Geisser correction was adopted when it was violated; for *post hoc* pairwise comparisons, Bonferroni correction was used. All tests were two-sided, and $P < 0.05$ was considered statistically significant.

Results

Comparison of baseline characteristics

No significant differences were observed between the two groups in age, body mass index (BMI), disease course, sex, affected knee, or American Society of Anesthesiologists (ASA) classification (all $P > 0.05$; **Table 1**).

Comparison of operation-related incices

No significant between-group differences were observed in OT, IBL, or drainage volume ($P > 0.05$; **Figure 1**).

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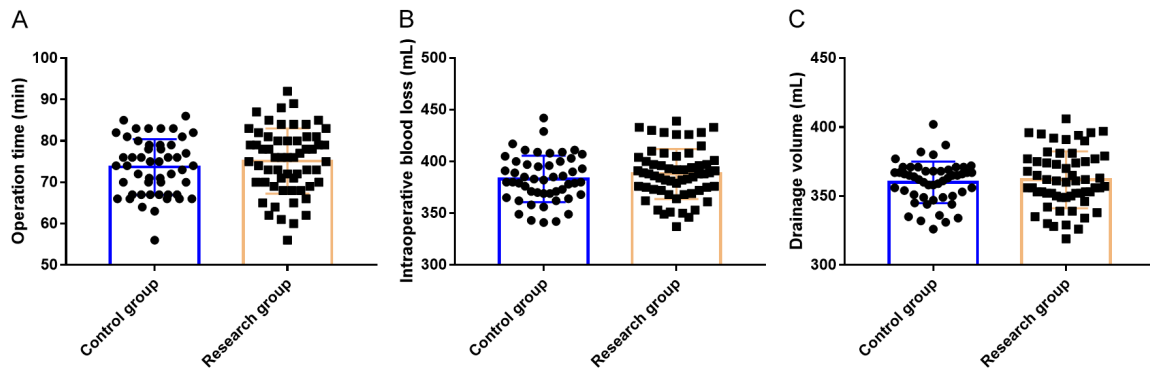


Figure 1. Comparison of perioperative indices between the two groups. A. Operative time; B. Intraoperative blood loss; C. Drainage volume.

Table 2. Comparison of procedural safety indices between the two groups

Variable	Control group (n=50)	Research group (n=59)	p
MCL re-rupture	-	0 (0.00)	
Periprosthetic infection	1 (2.00)	1 (1.69)	
Deep venous thrombosis	2 (4.00)	1 (1.69)	
Revision rate	3 (6.00)	0 (0.00)	
Total	6 (12.00)	2 (3.39)	0.139

Comparison of procedural safety

Within 1 year after surgery, no MCL re-rupture or revision procedures were recorded in the research group, whereas one case each of periprosthetic joint infection and DVT occurred. In the control group, one case of periprosthetic infection, two cases of DVT, and three revision procedures were recorded. The overall incidence of safety-related events was 3.39% in the research group, comparable to 12.00% in the control group ($P>0.05$; **Table 2**).

Comparison of postoperative recovery

No significant differences were observed between the two groups in the reduction in Hb level on postoperative day 3, time to active knee flexion of 90°, or length of hospital stay ($P>0.05$; **Table 3**).

Comparison of postoperative pain

No significant between-group differences were observed in VAS scores for pain at rest or MEP before surgery ($P>0.05$). After surgery, both pain-at-rest and MEP scores decreased significantly in both groups ($P<0.05$), with significantly lower scores observed in the research group

compared to the control group ($P<0.001$; **Table 4**).

Comparison of knee joint mobility and function

No significant between-group differences in baseline knee joint ROM or HSS scores were observed ($P>0.05$). After surgery, knee ROM and HSS scores increased in both

groups ($P<0.05$), with significantly greater knee ROM and higher HSS scores in the research group compared to the control group at 6 and 12 months postoperatively ($P<0.05$; **Figure 2**).

Mauchly's test of the sphericity assumption showed that the knee joint mobility did not satisfy the sphericity assumption ($P=0.004$). After Greenhouse-Geisser correction, the main effects of time ($F=74.115$, $P<0.001$), time $\times$ group interaction ($F=3.730$, $P=0.029$), and group ($F=16.446$, $P<0.001$) were significant. *Post hoc* pairwise comparisons indicated a gradual increase in knee joint range of motion over time across groups ($P<0.001$). The inter-group comparison further revealed greater knee joint mobility in the research group compared to the control group ($P<0.001$).

The HSS score satisfied the sphericity assumption (Mauchly's test; $P=0.568$). The repeated measures analysis of variance identified the presence of statistical significance in the main effect of time ($F=88.021$, $P<0.001$), time $\times$ group interaction ($F=3.127$, $P=0.046$), and group ($F=23.768$, $P<0.001$). According to *post hoc* pairwise comparisons, the HSS score increased significantly with time across groups ($P<0.001$), with the increase being significantly

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Table 3. Comparison of postoperative recovery between the two groups

Variable	Control group (n=50)	Research group (n=59)	t	P
Reduction in hemoglobin on postoperative day 3 (g/L)	24.46±7.63	24.27±7.28	0.133	0.895
Time to active knee flexion to 90° (d)	7.90±2.78	8.86±2.66	1.839	0.069
Length of hospital stays (d)	8.62±2.74	8.88±2.28	0.541	0.590

Table 4. Comparison of postoperative pain (VAS score) between the two groups

Variable	Control group (n=50)	Research group (n=59)	Z	P
Pain at rest (points)				
Before surgery	5.00 (4.00, 6.25)	6.00 (5.00, 6.00)	-1.138	0.255
After surgery	4.00 (4.00, 4.00)	4.00 (4.00, 4.00)	-4.383	<0.001
Movement-evoked pain (points)				
Before surgery	6.00 (4.00, 7.00)	6.00 (5.00, 7.00)	-0.236	0.814
After surgery	4.00 (4.00, 5.00)	4.00 (4.00, 4.00)	-3.482	<0.001

Note: VAS, visual analog scores.

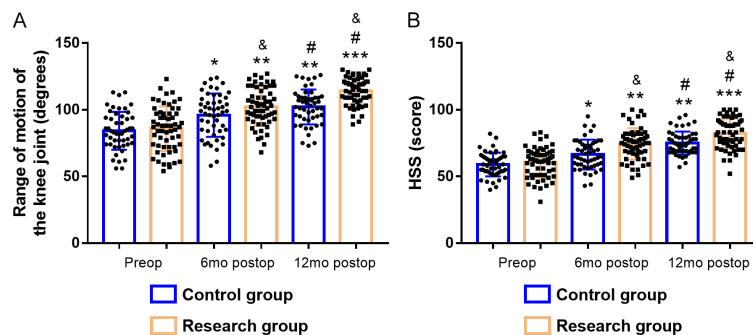


Figure 2. Comparison of knee joint mobility and function between the two groups. A. Joint range of motion; B. HSS scores. Note: HSS, Hospital for Special Surgery; * $P<0.05$, ** $P<0.01$, *** $P<0.001$, compared to preoperative values within the same group; # $P<0.05$, compared to the value at 6 months postoperatively within the same group; & $P<0.05$ compared to the Control.

Table 5. Comparison of inflammatory marker levels between the two groups

Variable	Control group (n=50)	Research group (n=59)	t	P
TNF- α (ng/mL)				
Before surgery	2.39±0.99	2.55±1.20	0.751	0.455
After surgery	4.24±1.76	3.20±1.49	3.341	0.001
CRP (mg/L)				
Before surgery	3.32±1.50	3.16±1.17	0.625	0.533
After surgery	5.33±2.12	3.95±1.83	3.648	<0.001
IL-6				
Before surgery	10.94±3.41	11.05±4.32	0.146	0.885
After surgery	19.82±4.49	16.46±3.68	4.294	<0.001

Note: TNF- α , tumor necrosis factor- α ; CRP, C-reactive protein; IL-6, interleukin-6.

greater in the research group than in the control group ($P<0.001$).

Comparison of inflammatory markers

Baseline TNF- α , CRP, and IL-6 levels were comparable between the two groups ($P>0.05$). On postoperative day 3, all markers increased significantly in both groups (all $P<0.05$); however, the levels of these markers were significantly lower in the study group than in the control group ($P<0.01$; **Table 5**).

Comparison of stress markers

Baseline NE and Cor levels were comparable between the two groups (all $P>0.05$). On postoperative day 3, both markers increased significantly in both groups ($P<0.05$), with the research group exhibiting significantly lower NE and Cor levels ($P<0.01$; **Table 6**).

Comparison of bone metabolism markers

Baseline BGP, CT, and OPG levels were comparable between the two groups (all $P>0.05$). At 6 months postoperatively, these markers increased significantly in both groups ($P<0.05$), with significantly higher levels

Table 6. Comparison of stress marker levels between the two groups

Variable	Control group (n=50)	Research group (n=59)	t	P
NE (ng/L)				
Before surgery	146.62±14.10	146.49±15.43	0.046	0.964
After surgery	181.20±12.56	157.49±13.71	9.347	<0.001
Cor (µg/L)				
Before surgery	79.44±9.32	81.58±10.27	1.131	0.261
After surgery	104.30±16.47	95.86±11.45	3.142	0.002

Note: NE, norepinephrine; Cor, cortisol.

Table 7. Comparison of bone metabolic marker levels between the two groups

Variable	Control group (n=50)	Research group (n=59)	t	P
BGP (µg/mL)				
Before surgery	3.09±1.13	3.16±1.32	0.294	0.769
After surgery	4.15±1.21	6.24±2.09	6.238	<0.001
CT (pg/mL)				
Before surgery	10.30±3.16	9.46±2.32	1.597	0.113
After surgery	10.50±2.49	11.50±2.15	2.250	0.027
OPG (pg/mL)				
Before surgery	2.74±1.25	2.81±1.36	0.278	0.782
After surgery	4.49±1.83	5.58±1.54	3.377	0.001

Note: BGP, osteocalcin; CT, calcitonin; OPG, osteoprotegerin.

observed in the research group ($P < 0.05$; **Table 7**).

Discussion

This study compared the clinical effects of two surgical approaches in KOA patients undergoing TKA. In the conventional TKA, the MCL complex was completely preserved without additional intervention, and only the medial soft tissues were sutured to the medial border of the patellar tendon. First, MCL reattachment during TKA produced perioperative outcomes comparable to the conventional TKA in terms of OT, IBL, and drainage volume. These findings suggest that MCL reattachment, though with additional operation steps, did not significantly prolong OT or increase surgical trauma, supporting its technical feasibility. Although MCL reattachment strategy requires the creation of 2-3 bone tunnels at the tibial insertion site and fixation of the MCL complex using #1 non-absorbable sutures, these steps can be completed simultaneously during bone cement

solidification without occupying additional independent surgical time, which explains the non-significant increase in OT [14]. Furthermore, the limited bone drilling depth (only penetrating the unilateral cortex), the potential tamponade effect of bone cement on bleeding from the bone surface, and the experience of the surgical team, may partly explain the non-significant increase in IBL [15]. The two management techniques also showed comparable overall incidences of safety-related events within 1 year after surgery. No revision procedures were recorded in the MCL group, compared to three cases in the control group. This finding indicates that MCL reattachment during TKA does not increase the procedural safety risk and may reduce the revision demand. One possible explanation is that reattachment of the MCL complex to its original insertion site through bone tunnels

using #1 non-absorbable sutures may help restore its anatomic tension and medial knee stability. This may reduce joint instability and abnormal prosthetic wear of associated with ligament laxity, thus ensuring procedural safety while helping to reduce the revision demand to some extent [16].

After the two interventions, the decrease in Hb level on postoperative day 3, time to achieve active knee flexion of 90°, and length of hospital stay were comparable between the groups, indicating that the additional procedures in the MCL reattachment did not delay postoperative recovery. Patients in the MCL reattachment group wore hinged knee braces for 6 weeks. Nonetheless, early functional training, including isometric quadriceps contraction and ankle-pump exercises initiated on postoperative day 1 as well as straight-leg-lifting exercise initiated on postoperative day 2, may have mitigated any possible restriction of knee flexion caused by brace use. This may partly explain why the time required to achieve active knee

flexion to 90° and the length of hospital stay were not prolonged [17]. MCL reattachment during KOA was also associated with greater reductions in pain at rest and MEP on postoperative day 3. This could be justified by the fact that anatomic reattachment of the detached MCL complex may restore medial soft-tissue tension and reduce micromotion and abnormal traction at the MCL insertion site during postoperative activities, thus effectively alleviating movement-related pain. At 6 and 12 months postoperatively, patients in the MCL reattachment group demonstrated greater improvements in knee joint ROM and function. The use of hinged brace for 6 weeks and early postoperative functional exercises in MCL reattachment group may promote MCL healing while facilitating the recovery of joint mobility [18]. Moreover, restoration of medial knee stability through MCL reattachment may support subsequent activities requiring greater flexion, thus contributing to knee functional recovery [19].

Surgical stress was evaluated from multiple perspectives, including inflammatory responses (CRP, IL-6, TNF- α), neuroendocrine stress responses (NE, Cor). IL-6 and TNF- α are key pro-inflammatory factors involved in KOA progression. Surgical trauma can activate the nuclear factor kappa B (NF- κ B) and mitogen-activated protein kinase (MAPK) signaling pathways, thereby promoting the release of proinflammatory mediators and amplifying the inflammatory cascade [1]. In this study, MCL reattachment during TKA was associated with significantly lower serum levels of inflammatory markers on postoperative day 3. These reduced inflammatory marker levels may be attributable to in-situ repair of the MCL complex, which helps avoid extensive dissection of the medial soft tissue bed, thereby minimizing the postoperative release of CRP, IL-6, and TNF- α . NE and Cor are commonly used indicators of the neuroendocrine response to surgical stress. NE reflects activation of the sympathetic nervous system, whereas Cor is released upon activation of the hypothalamic-pituitary-adrenal (HPA) axis. Elevated levels of NE and Cor indicate a more pronounced stress response [20]. Our findings demonstrated that MCL reattachment during TKA was associated with an attenuated neuroendocrine stress response. This attenuation may be partly explained by reduced postoperative pain, which in turn lowers norepinephrine release in the locus coeruleus and

cortisol production mediated by HPA-axis activation, ultimately lowering NE and cortisol levels [23].

BGP, CT, and OPG are associated with bone metabolism. BGP and OPG mediate the regulation of bone resorption and bone formation. Up-regulation of BGP helps inhibit osteoclast activity, OPG is essential for maintaining bone integrity, and CT reduces blood calcium by inhibiting osteoclast activity [21, 22]. In this study, MCL reattachment during TKA was associated with more favorable changes in bone metabolism markers at 6 months postoperatively. This may be explained by the improved mechanical environment around the prosthesis and the enhanced bone stress conduction, which together help maintain the balance of bone metabolism. Notably, the above mechanistic explanations are speculative and derived from the published literature; our study did not directly measure these signaling pathway molecules.

In this study, the MCL reattachment technique involves using #1 non-absorbable sutures to re-fix the MCL complex through a bone tunnel to its original position. The sutures, threaded through the bone tunnel, are then knotted and fixed outside the medial tibial cortex, with the force-bearing point located at the more rigid cortical exit site. In previous related reports, suture anchors, screw-washer constructs, and bone screws were commonly used as fixation methods. These fixation patterns rely on cancellous bone as the load-bearing point, achieving fixation through cancellous bone compression or threaded clamping [24-26]. Compared to the suture suspension penetrating the cortical bone used in this study, the pullout strength of the above methods demonstrated no superiority. The application of MCL reattachment in KOA has not been sufficiently studied, with most of the existing studies focusing on patients with MCL injuries [7, 27]. The clinical innovation of MCL reattachment discussed herein, which differs from previous studies, focuses on the fixation scheme and participant characteristics. Prognostic variations may be related to differences in fixation biomechanics, ligament management, postoperative rehabilitation, and prosthesis design.

This study had several limitations. First, there was a lack of inflammatory- and stress-related

data on the 7th postoperative day. Relevant data should be supplemented to comprehensively capture the dynamic regulation of long-term chronic inflammation and stress in KOA patients treated with MCL reattachment during TKA. Second, for bone metabolism indices, measurements were conducted only at baseline and 6 months after surgery, lacking dynamic data from the early postoperative period. Future prospective studies should be carried out to supplement early postoperative data, so as to distinguish whether the observed changes are caused by surgical intervention, rehabilitation strategies, or the exclusive effect of MCL reattachment. Finally, considering the absence of long-term prognosis assessment, an additional 5-year follow-up could be conducted to determine the long-term prognostic advantages of the combined treatment approach.

Conclusion

The application of the MCL reattachment technique during TKA in KOA patients is surgically feasible, as it does not raise procedural safety concerns or delay recovery, while effectively mitigating patients' short-term pain, improving knee joint mobility and function, and relieving surgical stress.

Disclosure of conflict of interest

None.

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