The Journal of Arthroplasty 30 (2015) 854–857

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Primary Repair of Iatrogenic Medial Collateral Ligament Injury During TKA: A Modified Technique

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ARTICLE INFO

Article history:
Received 29 September 2014
Accepted 30 December 2014

Keywords:
iatrogenic MCL injury
intraoperative repair
total knee arthroplasty
revision knee arthroplasty
synthetic ligament

ABSTRACT

Intraoperative injury to the medial collateral ligament (MCL) is a rare but important complication of total knee arthroplasty (TKA). While described treatment methods are mainly primary repair and revision with a more constrained implant, a few studies have investigated the outcomes of primary repair without constrained implants. A retrospective study was performed to evaluate the prevalence of iatrogenic injury to the MCL during primary TKA and determine the clinical outcomes of MCL repair augmented with synthetic material without the use of a constrained device. The incidence of intraoperative tear of the MCL was 0.43% (15/3432). No patient demonstrated instability during the follow-up period. Primary repair of iatrogenic MCL injury without the use of constrained implants appears to be a potential alternative that warrants further investigation.

Intraoperative injury to the medial collateral ligament (MCL) is a rare but important complication of total knee arthroplasty (TKA) [1–4]. Unfortunately, there is a paucity of articles in the literature defining the overall prevalence of this complication in large cohorts of TKAs. Injury to the MCL during TKA can lead to instability of the knee and ultimately failure. While MCL injury may occur extraoperatively due to chronic attenuation that is often found in valgus knees, iatrogenic injuries usually occur due to avulsion from the tibial insertion or direct transection at the level of the tibial osteotomy [5,6]. In case of iatrogenic injuries, treatment choices include primary repair, augmentation, use of more constrained implants, or a combination of the previous treatment options [2,7,8].

Many of the studies describing intraoperative injury of the MCL have recommended the use of more constrained implants to provide stability in the coronal plane rather than an isolated soft tissue repair [1,3,4,6]. While the use of constrained implants has the advantage of providing immediate stability without the need for ligamentous healing to occur or the need for a brace, these implants may have several disadvantages: they may place more stress on the cement bone–implant interfaces [2,9,10], be associated with increased wear [10], sacrifice host bone stock [11], and complicate future revisions if needed; and they are more expensive and difficult to insert. Thus, the use of constrained implants in general is discouraged when less constrained options are available that can adequately restore knee stability [1–3,9].

To avoid using constrained components and to take advantage of the high healing potential of the MCL [12–14], our strategy is primary repair of the MCL with augmentation, using synthetic graft material when intraoperative incompetence of the MCL is encountered. In the present study, we 1) retrospectively evaluate the prevalence of iatrogenic injury to the MCL during primary TKA and 2) determine the clinical outcomes of primary repair combined with synthetic ligament reconstruction without the use of constrained components.

Materials and Methods

Following institutional review board approval, we reviewed the demographic information and operative reports of all patients in our institution who underwent TKA by the senior author between January 2003 and November 2012 and had **iatrogenic** intraoperative injury to the MCL. Observations of sudden excessive exposure of the knee or unstable forward movement of the tibia were the primary symptoms leading to suspicion of MCL injury. Injury was diagnosed by examining the knee in mid-flexion and extension using valgus and varus stress tests and was confirmed by palpation. Direct exposure of the ligament was performed in all cases.

Demographic and clinical data were collected preoperatively, including age, weight, and height. In addition, the Knee Society Score (KSS) and body mass index (BMI) were calculated for all patients. Patients with a BMI greater than 30 were defined as obese, and those with a BMI greater than 40 were considered morbidly obese [4]. Preoperative full-length hip-to-ankle radiographs were reviewed for all included patients, and the anatomic axis of the lower extremity was calculated.

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2014.12.020.

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http://dx.doi.org/10.1016/j.arth.2014.12.020
0883-5403/

Surgical Technique

A standard midline skin incision with the sub-vastus approach was performed for exposure of all knees. The subperiosteal plane underneath the **superficial** MCL was found using either a scalpel or electrocautery, starting at the tibial joint line and continuing distally. To raise the medial sleeve off the tibia, an electrocautery or an osteotome was used, moving from anterior to posterior under direct visualization. Proceeding posteriorly, as little of the distal sleeve as possible was lifted to preserve the insertion of the MCL on the tibia. Dissection progressed to the mid-coronal plane at the level of the tibial joint line in neutral or minimal varus alignment. In more severely varus knees, this subperiosteal elevation was continued to the posteromedial corner of the knee, with the knee in flexion and the tibia gently drawn forward. Judiciously placed retractors were used to protect the sleeve of the MCL during tibial and femoral preparation (Fig. 1).

Intramedullary femoral instrumentation and extra-medullary tibial instrumentation were used in all patients. An injury to the MCL, if present, was typically diagnosed during the evaluation of ligament balancing with trial components. When a mid-substance tear of the MCL was identified, the location was determined and a repair was performed. Avulsion injuries, excluded from this study, were treated with other available options including anchor fixation or using augmentation with semi-tendonosis autograft augmentation.

After reaching full exposure of the MCL, the two ends were directly repaired using a modified Kessler stitch and an end-to-end repair was performed using non-absorbable sutures. The MCL did not have to be released from the tibia to aid reapproximation of the two ends in any cases. During this step, the knee was in extension and the spacer was kept in place to maintain proper tension on the ligament (Fig. 2).

Next, the outer aspect of the ligament (medial portion) was exposed and a synthetic ligament (Neoligaments™, Xiros Company, Leeds, UK) was applied that consisted of parallel longitudinal polyester fibers and an open mesh scaffold structure that encouraged tissue ingrowth. The graft was placed and sutured on the medial aspect starting proximally from the level of the medial epicondyle and proceeding to the distal end of the MCL at the attachment site to the tibia, using non-absorbable sutures (Fig. 3).

Additional deep interrupted suturing to the periosteum was performed proximally and distally at the femoral and tibial attachments. All these steps were done while the spacer was kept in place. After the repair, stability was confirmed by reexamination in extension and mid-flexion. The rest of the TKA was carried out in the usual manner using an unconstrained total knee implant (NexGen, Zimmer Inc., USA). Postoperatively, all patients were permitted to weight bear with an unlocked hinged knee brace for at least two weeks. Patients were advised to perform twice-daily physical therapy that emphasized range of motion and gait.

Clinical Follow-Up

All patients were followed up for a minimum of 6 months (average 12 ± 5 months, range 6 to 24). At the last follow-up evaluation, the range of motion was examined and KSS was obtained. To evaluate restoration of acceptable overall alignment, weight-bearing radiographs were reviewed and the anatomic axis was defined. Patients were also asked about their subjective sense of stability in the joint. The stability of the MCL was examined by applying a manual valgus stress to the knee at both 0° and 30° of knee flexion. The failure criteria were defined as opening of more than 5 mm in either position, or the absence of a fixed endpoint resistance to valgus stress in either position. To reduce bias, the physical examination, radiograph review, and KSS for all patients were performed by orthopedic surgeons other than those operating (ie, other co-authors besides ST and US).

Statistical Analysis

Changes in alignment and knee scores were evaluated using paired student t-tests. An alpha level of 0.05 was used to determine significance. All statistical analysis was conducted with SPSS (V24.0, IBM SPSS, Chicago, IL).

Results

In our series of 3432 TKAs, 15 knees (0.43%) were found to have intraoperative MCL tears. Review of the operative reports confirmed that the injuries were due to mid-substance transections in 11 knees and avulsion of the tibia or femur in 4 knees. All 11 cases with mid-substance MCL injuries were a result of direct injury from either the oscillating saw blade while performing the tibial cut or one of the sharp instruments that are used for medial subperiosteal lifting.

The mean age of the patients at the time of surgery was 64 years (range, 43 to 85). Ten of the patients were female and one was male. The preoperative diagnosis was osteoarthritis in 10 knees and rheumatoid arthritis in one knee. The mean BMI of the patients was 38 (range, 31 to 52), with 9 patients categorized as morbidly obese and 2 as obese.

No patients were lost to follow-up and none of the patients complained of knee instability. Upon physical examination, no patient was found to have laxity in the coronal plane in either 30° of flexion or full extension. All patients were able to walk without an assisting device at the time of the last follow-up and none underwent revision arthroplasty.

The mean KSS increased from a preoperative value of 42 points (range: 33 to 68) to 92 points (range: 76 to 100) at the time of final follow-up. Six knees had an excellent result (≥85 points) and 5 had a good result (70–84 points). We had no fair or poor results. **Flexion contracture** improved significantly, from a mean of 7° ± 0.2° preoperatively to a mean of 2° ± 0.1° at the time of final follow-up ($P < 0.0001$). The preoperative anatomic axis of the patients averaged 6.9° ± 0.3° of varus

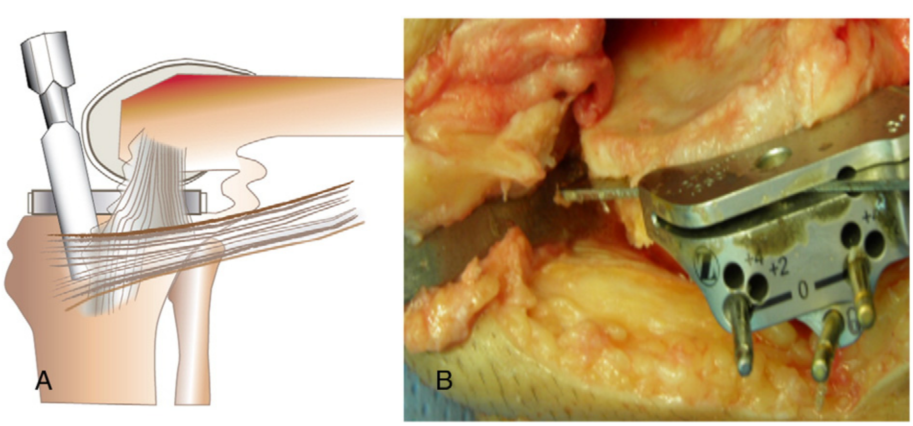

Fig. 1. Retractors placed to protect the sleeve of the MCL during tibial and femoral preparation.

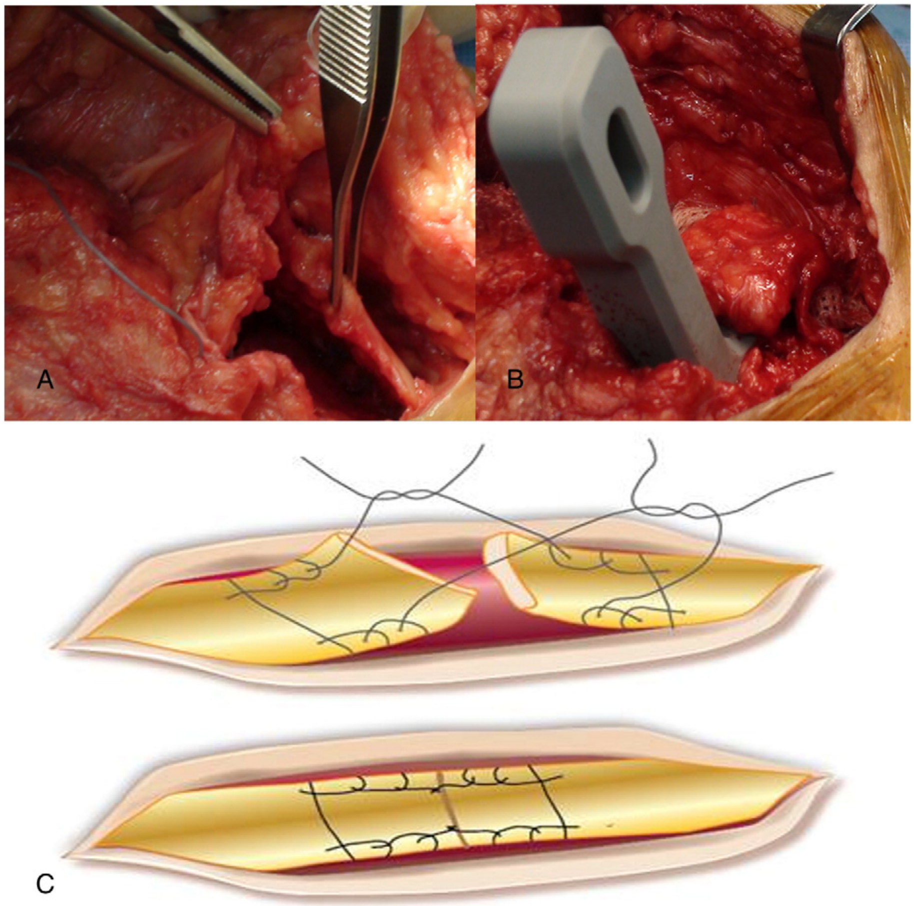

Fig. 2. (A and B) End-to-end repair using the Kessler. (C) Spacer kept in place to maintain proper ligament tension.

(range: 15° of varus to 5° of valgus), which improved significantly ($P < 0.0001$) to 5.8° ± 0.3° of valgus (range: neutral to 10° of valgus) postoperatively. No complication or wound infection was observed in these patients.

Discussion

MCL disruption during primary TKA is a rare but serious complication. The MCL plays an important role in coronal plane stability of the knee, and MCL insufficiency can result in the need for revision TKA. Nearly all reports on primary iatrogenic MCL injury repair have supported the use of unlinked constrained or hinged implants [1–3,9,15]. Since clinical studies have suggested that the MCL has a high potential to heal following injury [12–14,16], we opted to perform primary repair of the MCL after iatrogenic mid-substance tears during TKA with synthetic ligament augmentation. Follow-up at a minimum of six months after the operation revealed successful results with no patients demonstrating subjective or objective coronal plane instability or a need for revision.

Among the limitations is the relatively short minimum follow-up period, 6 months, which may not account for failures occurring after this period and may thus underestimate the failure rate of this technique. Another limitation is the absence of precise objective techniques and tools to measure joint stability. Among the limitations of the present study is the absence of precise objective techniques and tools to measure joint stability. As far as we know, there has been no established normal range of coronal plane stability to allow for an objective

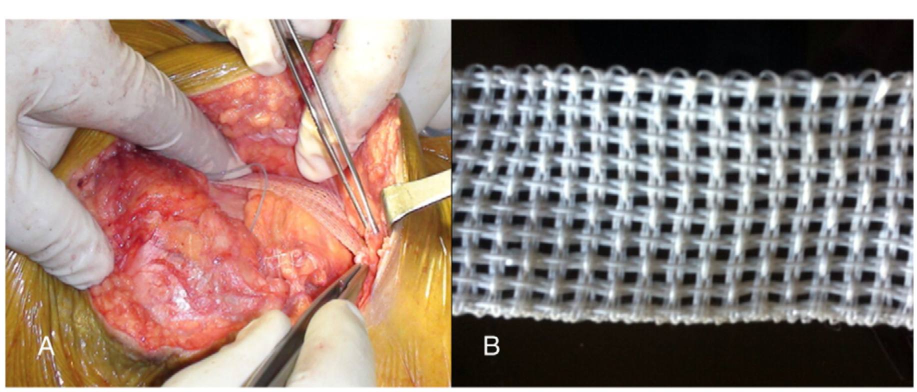

Fig. 3. (A) Graft placed and sutured from the level of the medial epicondyle and to the distal end of the MCL. (B) Picture of graft demonstrating parallel longitudinal polyester fibers and an open mesh scaffold structure that encourages tissue ingrowth.

evaluation of stability following TKA. Based on physical examination of this patient cohort for stability with the knee in full extension and in 30° of flexion, the patients demonstrated similar stability as other patients who had undergone primary TKA, but without MCL injury. Further, this study was not randomized and we thus cannot know with confidence if ligament repair would have been adequate alone, as has been described by others [8]. Additionally, given the relative infrequency of MCL injuries, we are likely underpowered and thus a power analysis was not performed. Finally, while we did not use constrained implants, as again this was not a randomized study, we do not know if our choice to avoid constrained implants led to better or worse outcomes. However, given the uniform success in our series and the negatives of using a constrained implant, it would seem that worse outcomes can be avoided in most cases where an adequate repair is obtained intraoperatively.

Leopold et al [8] described 16 cases in which an intraoperative MCL avulsion or transection was repaired primarily in conjunction with a cruciate retaining implant. Similar to our series, constrained implants were not utilized and in all cases stability of the knee was restored without subjective or objective evidence of instability [8]. It is important to note that in all cases of intraoperative MCL injury, posterior stabilized (PS) implants were used rather than cruciate retaining knees used in the series of Leopold et al. Given the role of the posterior collateral ligament (PCL) in coronal stability, retaining the PCL would give a secondary coronal stabilizer in these cases. Future studies should consider evaluating the importance of the PCL to the success of this technique.

In a study performed by Winiarsky et al, 50 morbidly obese patients who underwent primary TKA were evaluated, 8% of which had intraoperative iatrogenic injury to the MCL [4]; none of the patients with a normal BMI had this complication during surgery. MCL repair was performed using staples in 3 patients, and an unlinked constrained implant was used in the fourth patient, with no development of late instability in any of them. However, preoperative and postoperative KSSs were not reported. Furthermore, obtaining convenient surgical exposure is more difficult in obese patients [4], increasing the prevalence of iatrogenic MCL injury. This finding of a high rate of intraoperative MCL injury is supported by the high average BMI (38) of patients with iatrogenic injury in the present study.

A variety of comments have been made in the literature about the choice of treatment for intraoperative injury of the MCL. Most authors address this problem by using constrained implants [1,3,17], although some have described primary repair of the MCL using unconstrained implants [8,18,19]. However, these procedures were primarily performed in patients with preoperative valgus deformity and preexisting weakness, attenuation, or incompetence of the MCL.

Unlinked constrained implants transmit more stress to the cement bone–implant interfaces [2,9], which likely increases the incidence of aseptic loosening of the implant more than less-constrained designs [1,20,21]. One other disadvantage of using unlinked constrained prostheses in primary TKA is the higher amount of resection of the femoral intercondylar bone that is necessary. In addition, constrained implants are designed to be used with a stem. Because of these two features, there is limited available bone in case a future revision TKA is needed. In semiconstrained devices, the tibial component comes with an inter-condylar eminence, which may increase polyethylene wear debris. These components are also more expensive and difficult to insert. For these reasons, most arthroplasty surgeons are unwilling to use unlinked constrained prostheses when a less constrained option is available [1,3,15,20].

While the use of an allograft increases the cost of the procedure, it is likely a less expensive option than the use of more constrained implants but more expensive than the use of an autograft. Although augmentation with an autograft such as quadriceps tendon incurs less cost, the use of an autograft has its own complications, including those associated with an increase in operative time and a theoretical increased risk of periprosthetic fracture from fixation of the autograft, particularly at the femoral condyle. Increased follow-up and further studies are needed to more comprehensively evaluate the long-term risks, e.g. infection, and determine the cost effectiveness of this technique.

It is obviously best to avoid iatrogenic injury altogether. Several precautions could help to reduce the prevalence of MCL injury, such as having direct visualization of the ligament while elevating the medial subperiosteal soft tissues, and paying careful attention to the ligament during tibial and femoral preparation. Once the injury occurs, diagnosis and intraoperative treatment are very important to avoid the subsequent need for a revision TKA due to instability. Based on these results, we are optimistic that primary repair of the MCL using this modified synthetic ligament augmentation technique can restore the stability of the knee in the coronal plane and reduce the need for more constrained implants in such cases, preventing subsequent complications. Longer follow-up time in further studies is likely needed to prove these results.

Acknowledgements

We thank Chor Tan for the artistic and scientifically demonstrative illustrations.

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