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An Algorithmic, Pie-Crusting Medial Soft Tissue Release Reduces the Need for Constrained Inserts Patients With Severe Varus Deformity Undergoing Total Knee Arthroplasty

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ABSTRACT

Background: We studied the need to use a constrained insert for residual intraoperative instability and the 1-year result of patients undergoing total knee arthroplasty (TKA) for a varus deformity. In a control group, a "classic" subperiosteal release of the medial soft tissue sleeve was performed as popularized by pioneers of TKA. In the study group, an algorithmic approach that selectively releases and pie-crusts posteromedial structures in extension and anteromedial structures in flexion was used.
Methods: All surgeries were performed by a single surgeon using measured resection technique, and posterior-stabilized, cemented implants. There were 228 TKAs in the control group and 188 in the study group. Outcome variables included the use of a constrained insert, and the Knee Society Score at 6 weeks, 4 months, and 1 year postoperatively. The effect of the release technique on use of constrained inserts and clinical outcomes were analyzed in a multivariate model controlling for age, sex, body mass index, and severity of deformity.
Results: The use of constrained inserts was significantly lower in study than in control patients (8% vs 18%; $P = .002$). There was no difference in the Knee Society Score and range of motion between the groups at last follow-up. No patient developed postoperative medial instability.
Conclusion: This algorithmic, pie-crusting release technique resulted in a significant reduction in the use of constrained inserts with no detrimental effects in clinical results, joint function, and stability. As constrained TKA implants are more costly than nonconstrained ones, if the adopted technique proves to be safe in the long term, it may cause a positive shift in value for hospitals and cost savings in the health care system.

Adequate soft tissue balance at the time of total knee arthroplasty (TKA) prevents early failure [1]. In cases of varus deformity, once the medial osteophytes have been resected, a progressive release of the medial soft tissue sleeve (MSS) from the proximal medial tibia is needed to achieve balance [2-4]. The "classic" medial soft tissue release technique, popularized by John Insall et al [5], consists of a sharp subperiosteal dissection from the proximal medial tibia that includes superficial and deep medial collateral ligament (MCL), semimembranosus tendon, posteromedial capsule, along with the pes anserinus tendons, if needed. However, this technique allows little control over releases that selectively affect the flexion and extension gaps [6]. When severe deformity is present, an extensive MSS release can cause iatrogenic medial instability [7] and the need to use a constrained TKA implant [8,9].

In recent years, investigators suggested that the MSS can be elongated by performing selective releases [3,10-13]. Elongation of the MSS in extension involves the release of the posterior oblique ligament, posteromedial capsule, and semimembranosus tendon insertion. In flexion, the anterior aspect of the MCL may be released [3]. If additional release of the MSS is needed in flexion and/or extension, multiple needle punctures (MNPs) can be performed on the taut structures [3,10].

When collateral ligament laxity and/or imbalance persist despite reconstruction of the joint line, mechanical alignment,

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component rotation, and attempt at ligament balancing, a constrained TKA implant may be necessary [14]. The use of a constrained TKA may be associated with greater wear, osteolysis, and aseptic loosening rates [15]. In addition, in our institution devoted to musculoskeletal care, a constrained TKA construct is up to 205% more expensive than the standard TKA construct with a posterior-stabilized (PS) nonconstrained insert (courtesy of operating room Materials Management).

The use of a soft tissue release technique that involves pie-crusting is not widely accepted. Concerns have been voiced regarding the potential postoperative disruption of the MCL when pie-crusting is performed. This could lead to early postoperative joint instability [12,16,17].

The aims of this study are (1) to determine if the previously described algorithmic approach to the release of the MSS reduces the need for constrained inserts in primary TKA; (2) to determine if the use of constrained inserts is affected by the severity of preoperative deformity; and (3) if there is any detrimental clinical effect of the algorithmic release when compared to the classic release technique.

Material and Methods

We performed a retrospective review of 387 selected patients who underwent 418 primary TKAs (31 bilateral) for osteoarthritis with a varus deformity and with a minimum clinical follow-up of 1 year. All surgeries were performed by a single surgeon (AGDV) from October 2009 to September 2014. Two patients (2 TKAs) were excluded: one developed aseptic loosening of the patella, and one patient died of an autopsy-proven myocardial infarction 6 weeks postoperatively. The remaining 385 patients (416 TKAs) were included in this study.

Surgical technique involved a horizontal tibial cut using an extramedullary alignment jig, distal femoral cut using an intramedullary alignment jig at 5° of valgus, anatomic rotation of the femur after the epicondylar axis (measured resection), and posterior referencing instrumentation. PS implants were used with the possibility of using a conventional PS insert or a constrained one depending on the ligament stability detected after attempt at ligament balance [9].

The first 228 TKAs, which were operated on between October 2009 and December 2011, were balanced following the classic MSS release technique [5] and constituted the “control group.” In the subsequent 188 TKAs operated on between January 2012 and September 2014, balance was achieved using the algorithmic, pie-crusting technique proposed by Ballemans et al [10] and constituted the “study group.”

The algorithmic approach included the resection of the posterior osteophytes as the initial balancing gesture. If additional MSS release was necessary to achieve a rectangular extension gap, a subperiosteal release of the posterior aspect of the MSS was performed with electrocautery, detaching the posterior aspect of the deep MCL, posteromedial capsule, and semimembranosus tendon for the proximal and medial tibia [3]. Dissection did not extend more than 1.5 cm distal to the joint line. If additional release was necessary, the medial compartment was tensioned with a laminar spreader in extension, and MNPs (generally less than 6) were performed in the tout portion of the MSS using a 16G needle. After performing the posterior condylar resection, removing PCL and posterior osteophytes, the flexion gap was assessed using spacer blocks and laminar spreaders. If additional release was necessary to balance the flexion gap, MNPs in the anterior aspect of the MSS were performed.

A knee was considered to be well balanced when rectangular symmetric gaps were obtained, and medial and/or lateral opening with the knee in extension and flexion did not exceed 3 mm with varus and valgus stresses applied. A PS insert was used in well-balanced knees. In the presence of ligament imbalance or irreconcilable flexion or extension mismatch, a constrained insert was implanted.

Intraoperative and perioperative care remained consistent during the study period, with the exception of using topical transexamic acid in the last 29 TKAs in the study group. Regional anesthesia was used. All patients were mobilized on or before postoperative day 1. Continuous passive motion machines were used only during hospitalization. Each patient received standardized pain control, multimodal venous thromboembolism prophylaxis [18], and medical comanagement.

The analyzed preoperative variables included: age, gender, body mass index (BMI), deformity, and Knee Society Score (KSS) [19]. The anatomic varus deformity was measured on standing films and grouped according to KSS criteria ($\leq$5°, 6°-10°, 11°-15° and $\geq$16°). Four groups were defined based on the severity of the deformity: mild ($\leq$5°), moderate (6°-10°), marked (11°-15°), or severe ($\geq$16°).

The primary outcome measure was the use of a constrained insert. Secondary outcomes included functional- and knee-specific KSS at 6 weeks, 4 months, and a year postoperatively; symptomatic postoperative medial instability; and the need for manipulation under anesthesia. Special attention was paid to the development of clinical symptoms of postoperative instability during the follow-up period.

Descriptive statistics included mean and standard deviation for continuous variables and frequency and percentages for categorical variables. Demographic characteristics, functional KSS and knee-specific KSS, and constrained insert use were compared between the study and control groups using 2-sample *t* tests for continuous variables and chi-square tests for categorical variables. A multiple logistic regression analysis was performed to compare the difference in the use of a constrained insert between the study and control groups, controlling for age, gender, BMI, severity of varus deformity, preoperative functional and knee-specific KSS. The results were summarized using odds ratio, 95% CI, and *P* values.

The comparison of constrained insert use between the study and the control groups was stratified by the severity of the varus deformity. Chi-square tests and multiple logistic regression analysis were performed. A Cochran–Mantel–Haenszel test was used to examine whether there is a difference in the proportion of constrained insert use between the study and control groups, after controlling for severity of varus deformity, and a Breslow–Day test for homogeneity was used to test whether the relationship between technique and constrained insert use differed between deformity strata.

All tests were 2-sided with a significance level of 0.05. All analyses were conducted using SAS for windows 9.3 (SAS Institute Inc, Cary, NC).

Results

There were no significant differences in preoperative age, gender, BMI, range of motion, functional KSS, knee-specific KSS, and severity of varus deformity between the study and control groups (Table 1).

The use of constrained inserts was significantly lower in the study than in the control group (8% vs 18.4%, respectively; $P = .002$). There was a significant increasing linear trend in constrained insert use with increasing varus deformity ($P = .002$). The difference in the use of constrained inserts was not significant in the univariate analysis of study and control patients with mild, moderate, and marked deformity ($P = .49$, .08, and .10, respectively) but was significant in patients with severe deformity ($P = .03$; Fig. 1).