Iatrogenic popliteus tendon injury during total knee arthroplasty results in decreased knee function two to three years postoperatively

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Received: 9 June 2012 / Accepted: 11 July 2012 / Published online: 1 August 2012
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Abstract

Purpose The popliteus tendon is known to play a key role in the stability of the posterolateral corner of the knee. While prior work suggests that isolated sectioning of the popliteus tendon has little consequence for the static stability of the knee following TKA, no studies have evaluated the effect of iatrogenic popliteal tendon injury on patient oriented outcome and knee function following TKA. The aims of this study are (1) to compare patient-oriented outcome scores of patients who suffered an iatrogenic injury to the popliteus tendon with a control group without such an injury and (2) to identify risk factors associated with iatrogenic injury to the popliteus tendon.

Methods Fifteen patients with an iatrogenic complete transection of the popliteus tendon during TKA were compared to the 666 patients who underwent TKA during the same time period without popliteus tendon injury.

Results Postoperatively, IKS knee scores were similar between the two groups; however, significantly lower IKS

function scores were noted in the study group (71 ± 31) compared to the control group (86 ± 19) ($p=0.0036$). Iatrogenic popliteal tendon injury was only noted to occur in patients in whom components of size four or smaller were used.

Conclusions Intraoperative complete section of the popliteus tendon during the performance of TKA results in decreased IKS functional scores two to three years postoperatively. Patients with smaller knees may be at higher risk for this complication.

Introduction

The popliteus is known to play an important role in the stability of the posterolateral corner of the knee. The muscle originates on the posterior surface of the tibia, proximal to the soleal line where it forms the floor of the popliteal fossa [14–16]. From the myotendinous junction at the superolateral border of the muscle, its tendon continues proximally and laterally, entering the knee joint. It passes deep to the arcuate ligament, through the popliteal hiatus, and deep to the lateral collateral ligament before inserting into a sulcus on the lateral femoral condyle just anterior and inferior to the origin of the lateral collateral ligament. The popliteus tendon sends attachments to the posterior horn of lateral meniscus (the popliteal meniscal ligament) and to the styloid process of the fibula (the popliteal fibular ligament) [4, 8, 10, 17]. This muscle is unique in that unlike most muscles in the body, its insertion is proximal to its origin [2]. Contraction of the popliteus muscle causes internal rotation of the proximal tibia relative to the femur. This rotation is necessary to “unlock” the fully extended knee at the initiation of joint flexion [14].

Level of evidence Retrospective comparative study—Level III

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There is a vast amount of literature exploring the aetiology and effects of injury to popliteus tendon and posterolateral corner in the normal knee. The popliteus complex, consisting of the popliteus tendon, popliteofibular ligament, and arcuate ligament, is a critical stabiliser of the posterolateral corner [3, 14, 16]. Each component contributes to the role of the complex as the primary restraint to excessive posterolateral rotation of the tibia relative to the femur [12, 14].

The precise function of popliteus tendon following total knee arthroplasty (TKA) is less clear, but it is thought to contribute to varus knee stability, particularly in flexion [6]. Following TKA, the popliteus may not have the same critical functions due to the combination of increased constraint in the TKA relative to the native knee and relatively lower functional demand in this patient population [7]. We are aware of no reports of the functional effect of an intraoperative lesion and subsequent dysfunction of the popliteus tendon in patients undergoing primary TKA. We postulate (1) that patient-oriented outcome scores of patients who suffered an iatrogenic injury to the popliteus tendon differ from those of a control group without such an injury and (2) that knees requiring the use of small components are at increased risk of iatrogenic injury to the popliteus tendon.

Materials and methods

Patients

A total of 1,312 patients undergoing TKA at our centre between 2001 and 2008 were retrospectively identified from a prospectively collected database. Patients undergoing TKA for osteoarthritis or chondrocalcinosis with no history of prior knee surgery other than arthroscopy were eligible for inclusion in the study ($n=918$). Complete clinical and radiographic data with minimum one-year follow-up was available in 681 patients (74 %). Of these patients, 15 patients were noted to have iatrogenic complete disruption of the popliteus tendon intraoperatively. These 15 patients formed the study group, while the remaining 666 patients formed the control group.

Preoperative demographic data describing the study and control groups are shown in Table 1. No significant differences were noted between the two groups with regard to patient age, gender, size, diagnosis, International Knee Society (IKS) knee or functional score [5], range of motion, or severity of osteoarthritis.

Surgical indications and technique

All patients underwent surgery at an academic medical centre under the direct supervision of experienced, fellowship-

Table 1 Preoperative comparison of the study and control groups

Characteristic	Study ($n=15$)	Control ($n=666$)	Significance
Age (years)	73±8	71.8±8.2	$p=0.57$
Gender	12 female (80 %) 3 male (20 %)	476 female (71.4 %) 190 male (28.6 %)	$p=0.34$
Weight (kg)	75±11	78±14	$p=0.35$
Height (cm)	163±6	164±6	$p=0.68$
BMI (kg/m^2)	28±4	29±5	$p=0.51$
Diagnosis			$p=0.49$
Medial tibiofemoral osteoarthritis	11 (73.3 %)	518 (78.8 %)	
Lateral tibiofemoral osteoarthritis	2 (13.3 %)	99 (14.9 %)	
Bicompartmental osteoarthritis	0 (0 %)	7 (1 %)	
Patellofemoral osteoarthritis	2 (13.3 %)	29 (4.4 %)	
Chondrocalcinosis	0 (0 %)	13 (2 %)	
IKS knee score	48±17	52±17	$p=0.41$
IKS function score	56±20	59±19	$p=0.57$
Mechanical axis	174±7	174.8±7.2	$p=0.67$
Extension deficit	2.4±3.5	2.1±4.5	$p=0.80$
Flexion	123.7±13.4	119.7±17.1	$p=0.37$
Ahlback grade			$p=0.88$
Grade 1	0 (0 %)	7 (1 %)	
Grade 2	4 (31 %)	147 (24 %)	
Grade 3	6 (46 %)	327 (52 %)	
Grade 4	3 (23 %)	142 (23 %)	
Not reported	2	55	

trained orthopaedic surgeons. The most common diagnosis in both the study and control groups was degenerative osteoarthritis of the medial compartment, and no significant differences in diagnoses were noted between the groups (Table 1). A medial parapatellar approach was used in 13 patients with medial, bicompartamental, and patellofemoral OA and those with chondrocalcinosis. A lateral parapatellar approach was used in patients with lateral compartment OA. Cemented, posterior-stabilised components (HLS Noetos, Tornier Inc, St. Ismier, France) were used in all knees.

Retrospective evaluation

A retrospective review of prospectively collected clinical data was performed. Data collected from the clinical evaluation included assessment of range of motion and evaluation of coronal plane laxity in flexion and extension on physical examination. Additionally, patients completed a questionnaire allowing calculation of IKS knee and functional scores. Their overall subjective satisfaction with the procedure was documented as very satisfied, satisfied, disappointed, or dissatisfied.

Statistics

Quantitative values were compared with *t*-tests. Proportions were compared with Fisher exact tests. A power analysis determined that with 15 patients in the study group and 666 patients in the control group, a difference of 8 points in the IKS knee score and 12 points in the IKS function score could be detected with $\alpha=0.05$ and a statistical power of 80 %. An α of $p<0.05$ was considered statistically significant throughout the analysis.

Results

In the study group, 13 of 15 patients (87 %) had femoral and tibial components of size 3 or smaller and no implants larger than size 4 were used (Table 2). In the control group, 474 of

666 patients (71 %) had femoral and tibial components of size 3 or smaller and implants of all sizes were used (Table 3).

Follow-up was longer in the study group (39 months) than the control group (27 months). Both groups demonstrated significant improvement in IKS knee and function scores postoperatively. Subjective patient satisfaction and IKS knee scores were similar between the two groups; however, significantly lower IKS function scores were noted in the study group (Table 4). No differences in limb alignment or extension deficit were noted between the two groups, but four degrees more flexion was achieved in the study group (Table 4). Varus laxity in flexion was documented clinically in two of 15 patients (13 %) in the study group and seven of 666 patients (1.1 %) in the control group ($p=0.015$). Revision was performed in one patient in the study group for persistent pain, but this patient did not exhibit increased laxity with varus stress.

Discussion

The most significant finding of this study is that iatrogenic complete laceration of the popliteus tendon results in decreased IKS functional scores two to three years postoperatively. This difference may be related to increased postoperative laxity with varus stress in flexion, which can be difficult to assess objectively. Further, all popliteal tendon injuries in this series occurred in patients in whom size 4 or small implants were used. No significant differences in patient height or weight were noted between the study and control groups, although the small number of patients in the study group leaves this study relatively underpowered to detect such differences.

Several studies have evaluated the impact of releasing the popliteus tendon on static knee laxity. A laboratory study by Nagamine et al. evaluating the effect of releasing an abnormally tight popliteal tendon following TKA did not identify increases in rotational or coronal plane laxity with semi-constrained or unconstrained components [13]. In a cadaveric sectioning study, Kanamiya et al. noted no significant effects of isolated sectioning of the popliteus tendon [6]. They noted significant changes in static knee stability only in cases in which the other posterolateral knee structures were also sectioned. Several other authors have documented similar increases in laxity following release of the popliteus tendon in association with other posterolateral knee structures [9, 11].

In a blinded, randomised trial, Kesman et al. documented no difference in subjective balance of the knee following intentional sectioning of the popliteus tendon during TKA [7]. They did not report effects of this sectioning on patients' clinical outcomes. The *in vitro* portion of the same study

Table 2 Component size in the study group

Component	Size of the femoral component						
Size of the tibial component	1	2	3	4	5	6	Total
1	1						1
2		7	2				9
3			3				3
4				2			2
5							
6							
Total	1	7	5	2			15

Table 3 Component size in the control group

Component	Size of the femoral component						
Size of the tibial component	1	2	3	4	5	6	Total
1	52	35					87
2	5	149	98				252
3		4	117	72			193
4			3	64	30		97
5				5	22	6	33
6						4	4
Total	57	188	218	141	52	10	666

demonstrated no change in load distribution between the medial and lateral tibial plateaus immediately following popliteus tendon transection near full extension, but did not evaluate the effect of popliteus tendon transection with the knee in flexion.

The precise role of popliteus tendon in dynamic knee stability following total knee arthroplasty is much less clear. Several case reports have explored the relationship between popliteus tendon dysfunction and results of TKA. Ugutmen et al. described a case of lateral knee dislocation following TKA in which iatrogenic lateral collateral, arcuate ligament, and popliteus tendon injury occurred [18]. Barnes et al. reported a case of popliteus tendon impingement following TKA caused by the tendon snapping over the posterolateral aspect of the femoral component [1]. Surgical release of the tendon from its femoral insertion relieved the problem in this patient without reported functional deficit.

Taken together with the literature described above, our findings suggest that while isolated popliteal tendon injury may not contribute significantly to static knee stability following TKA, especially near full extension, there may be a functional loss associated with such intraoperative injuries. In this study, we made no effort to repair the popliteal tendon following injury. It is unclear what effect, if any, a tendon repair would have on outcomes.

This study has several limitations. First, the small sample size limits our ability to compare the characteristics of the study group and the control group. The study is underpowered to detect any differences between the groups based on component size, patient size, or patient gender. We did, however, note that this complication occurred only in patients in whom relatively small components were used. Risk is theoretically increased in patients with valgus pre-operative alignment but we lack sufficient power to evaluate this hypothesis. Second, our study was performed with one particular posterior-stabilised prosthesis type. It is unclear whether our results are implant-specific or can be generalised to all semi-constrained prostheses, included cruciate-retaining designs. Third, the retrospective nature of this study limits our certainty as to when in the surgical procedures the iatrogenic injury to the popliteus tendon occurred. We believe it to be a greatest risk during the posterior lateral femoral condyle cut but it may also be at risk during the tibial cut. Finally, in spite of the fact that all cases were performed under the direct supervision of an experienced orthopaedic surgeon, we lack data regarding the specific level of training of the person making the cuts in each case. We are therefore unable to comment on the influence of the experience of the operator on the risk for iatrogenic popliteal tendon injuries.

Table 4 Postoperative comparison of the study and control groups

Variable	Study (n=15)	Control (n=666)	Significance
Time to follow-up (months)	39±14	27±19	<i>p</i> =0.018
Revised	1 (6.7 %)	15 (2.2 %)	<i>p</i> =0.26
IKS knee score	92±12	92±11	<i>p</i> =0.95
IKS function score	71±31	86±19	<i>p</i> =0.0036
Subjective satisfaction			<i>p</i> =0.54
Very satisfied	10 (67 %)	462 (69 %)	
Satisfied	4 (27 %)	180 (27 %)	
Disappointed	1 (7 %)	22 (3 %)	
Dissatisfied	0 (0 %)	2 (0.4 %)	
Extension deficit	0.2±0.5	0.1±1.6	<i>p</i> =0.79
Flexion	121.1±11.0	125.7±8.2	<i>p</i> =0.03
Mechanical axis	178.7±3.0	179.7±9.5	<i>p</i> =0.78

Conclusions

Intraoperative complete laceration of the popliteus tendon during the performance of TKA results in decreased IKS functional scores two to three years postoperative. Patients with smaller knees may be at higher risk for this complication.

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