

Original Research Article

Iatrogenic Injuries of the Popliteus Tendon during Total Knee Arthroplasty

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Abstract: The popliteus tendon is known to play a key role in the stability of the posterolateral corner of the knee. Its role in the stability of the replaced knee remains contentious. The aim of this study was to determine the impact of an iatrogenic lesion of the popliteus tendon during total knee arthroplasty surgery on the stability and function of the knee. We searched in the operating report registers, patients with complete iatrogenic injury of the popliteus tendon during total knee arthroplasty on genu-varum. We evaluated postoperative varus, mobility and stability and we calculated their International Knee Society scores. Among the 423 reports of total knee arthroplasties consulted in the operating report registers, we found seven patients with a complete iatrogenic injury of the popliteus tendon. All patients had preoperative extension deficit. All operated knees were stiff, tight and small. At postoperative follow-up, all the knees had good stability and function. All the patients were satisfied. Finally, we concluded that the isolated section of the popliteus tendon does not seem to modify the static stability of the knee. However, it can cause a decrease in long-term functional scores. More work is needed to increase understanding of the impact of this iatrogenic lesion on long-term function.

Keywords: Popliteus tendon, total knee arthroplasty, knee, surgery, stability, function.

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INTRODUCTION

Iatrogenic injury of the popliteus tendon (PT) during total knee arthroplasty (TKA) is an intraoperative incident that has been little studied in the literature. Its frequency is very variable: it is 2.2% in the series of De Simone et al. [1] and it is 52% in the series of Aki et al. [2]. The functional consequences of this incident have not yet been elucidated. The purpose of our study was to determine the repercussions of an iatrogenic lesion of the PT during TKA, on the stability and on the function of the knee.

MATERIAL AND METHODS

We searched in the operating report registers, patients with complete iatrogenic rupture of the popliteus tendon (PT) during total knee arthroplasties (TKAs) on genu-varum. Our research concerned TKAs carried out between January 2014 and December 2019. We did not include patients having TKA on a genu-valgum, or patients having constraint implant, or patients having TKA revision.

We collected in patients with a complete iatrogenic rupture of PT: age, preoperative varus, preoperative mobility, preoperative stability, type and size of prosthesis (postero-stabilized (PS) or retaining the posterior cruciate ligament (LCP)), treatment of the PT injury, and follow up, postoperative varus, mobility and stability at follow up. We calculated also the International Knee Society (IKS) knee and functional scores. The overall subjective satisfaction of patients with the procedure was documented as very satisfied, satisfied, disappointed, or dissatisfied. We respected the anonymity of the patients in all stages of our research.

RESULTS

Among the 423 reports of TKAs consulted in the operating report registers, we found seven patients with a complete iatrogenic rupture of the PT (1.6% of cases): five women and two men (Table 1). The average age was 69 years old (56 to 77 years old). All patients had knee osteoarthritis. The average genu-varum was 16 ° (8 ° to 30 °). The mean flexion was 102.8 ° (90-120 °). All patients had an extension deficit. The mean extension deficit was 11.4 ° (from 5 ° to 20 °). Two patients had preoperative varus laxity.

All patients were operated on by experienced surgeons. All TKAs were postero-stabilized (PS). All operated knees were stiff and tight. All sizes of femoral and tibial prosthetic implants were smaller or equal to 3. Only one patient had a PT suture and the others had no tendon repair.

The mean follow-up was four years. The mean postoperative varus was 3.14 ° (0 ° to 8 °). The mean mobility at follow-up was 2.85 ° / 108.5 °. Average IKS knee score was 89.85 (84 to 93). Average IKS function score was 71.42 (from 65 to 80). At follow-up, six knees were stable and one patient present a varus laxity less than 10 °. All patients were satisfied.



Fig-1: The popliteal tendon identified during total knee replacement surgery

Table-1: Table summarizing the data of our case series

	N°1	N°2	N°3	N°4	N°5	N°6	N°7	Average
Age (Years)	56	75	69	73	66	77	68	69
Gender	Man	Women	Women	Man	Women	Women	Women	-
Pre-operative Varus	30	12	16	8	22	10	14	16
Mobility (Extension / Flexion)	20°/ 90°	10°/ 100°	5°/ 120°	5°/ 120°	15°/ 100°	10°/ 100°	15°/ 90°	11.4°/ 102.8°
Pre-operative stability	Varus laxity	-	-	-	Varus laxity	-	-	-
Type and size of the prosthesis	PS F3/T3	PS F3/T2	PS F2/T2	PS F3/T3	PS F3/T3	PS F2/T2	PS F3/T3	-
Treatment of PT lesion	Suture	No repair	No repair	No repair	No repair	No repair	No repair	-
Post-operative follow-up (months)	36	50	26	58	40	48	84	48.85
Post-operative Varus	8°	3°	2°	0°	5°	1°	3°	3.14°
Mobility at follow-up	5°/ 90°	0/ 110°	0°/ 120°	5°/ 120°	5°/ 110°	0°/ 110°	5°/ 100°	2.85°/ 108.5°
Stability at follow-up	Varus laxity < 10°	-	-	-	-	-	-	-
IKS knee score	84	92	93	92	90	90	88	89.85
IKS Function score	65	75	80	70	65	80	65	71.42
Patient satisfaction	Satis-fied	Satis-fied	Very satisfied	Satis-fied	Satis-fied	Very satisfied	Satis-fied	-

(-): no laxity; PS: Postero-stabilized prosthesis; F / T: Size of the femoral prosthetic component / Size of the tibial prosthetic component; IKS scores: International Knee Society scores.

Table-2: Table summarizing the conclusions of Studies on living humans

Authors	Type of study	Evidence Level	Number	Conclusions
Apinyankul (2020) [3]	Retrospective study + Cadaveric study	III	Phase 1 (Clinical study) 132 patients: 87 conventional design TKAs / 45 highflex design TKAs. Phase 2: cadaveric study (18 cadavers were dissected to reveal 36 PT origin sites).	High-flex TKA prosthesis with thicker posterior condyle relates to higher possibility of PT footprint injury compared to standard one.
Aki (2016) [2]	Retrospective case-control study	III	275 TKA: 200 with PCL conserved/ 75 PS	Partial or total excision of the PT femoral footprint was identified in 52% of the knees. Risk Factors: Thick resection of the distal femoral condyle and small knees.
Vito de Simone (2012) [1]	Retrospective comparative study	III	15 TKA PS with iatrogenic section of PT / 666 TKA with intact PT.	An iatrogenic section of the PT leads to a decrease in the IKS scores after 2 to 3 years. Risk factors: Small knees.
Kesman (2011) [7]	Randomized blind trial + cadaveric study	II	18 TKA PS randomized into 2 groups. + 3 cadaverous knees	The section of the PT has no effect on the stability of the knee.
Ugutmen (2008) [12]	Case report	IV	1 TKA	Disinsertion PT + lesion of AL + LCL. Treatment: Trans-bone reinsertion of PT + repair of AL + LCL. Good result after 14 months.

TKA: total knee Arthroplasty; PCL: posterior cruciate ligament; PS: postero-stabilized; PT: popliteal tendon; IKS: International Knee Society; LCL: lateral collateral ligament; AL: arcuate ligament.

Table-3: Cadaveric studies

Authors	Number of cases	Conclusions
Athwal (2016) [10]	9 TKA retaining the PCL	No significant effect of the isolated section of the PT on the lateral stability of the knee after the TKA retaining the PCL
Takahashi (2015) [6]	21 TKA	During a TKA, the femoral insertion of the PT could inevitably be excised, regardless of technical problems. The LCS system design preserves the insertion of the PT. Risk factors: small knees and female sex.
Ghosh (2014) [9]	8 TKA PS	No significant effect of the isolated section of the PT in the TKA PS. Above 90 ° flexion, laxity increases significantly.
Cottino (2014) [11]	10 TKA retaining the PCL / 10 TKA PS	The PT section destabilized the lateral and medial compartment of the knee. A greater effect was observed in the lateral compartment in extension and especially in flexion. Preservation of the PCL does not prevent the opening of the lateral compartment after the PT section.
Tantavisut (2012) [4]	14 TKA PS	The flexion and extension spaces increased significantly medially and laterally after complete section of the PT. Risk factors: small knees and thicker resection of the external femoral condyle
Kanamiya (2002) [8]	17 TKA PS	No significant effect of the isolated section of the PT in the TKA PS. Significant effect only when the other posterolateral structures were sectioned.

TKA: total knee Arthroplasty; PCL: posterior cruciate ligament; PS: postero-stabilized; PT: popliteal tendon; LCS system: low contact stress system.

DISCUSSION

At the end of our study, we finally found that the knees with iatrogenic PT lesion during TKA were

stable and had relatively good functional results with satisfaction of all patients.

The popliteus tendon (PT) is known to have an important role in the stability of the postero-lateral corner of the knee (Figure 1). Its role in the stability of the TKA is still controversial. Few publications have studied iatrogenic popliteus tendon injury in TKA surgery. Our literature search found only four case series and one case report (Table 2).

The literature has reported two types of iatrogenic lesions of PT during TKA: partial or total iatrogenic transection of the tendon and partial or total resection of its footprint. Total intraoperative iatrogenic transection of PT was reported in 2.2% of TKAs in the series of De Simone *et al*. [1]. Aki *et al*. [2] found that partial or complete resection of the PT femoral footprint was identified in 52% of TKAs. Apinyankul [3], demonstrated that the prevalence of popliteus footprint injury was identified in 17.8% of high-flex TKAs and in 3.5% of conventional design TKAs. In our case series, the iatrogenic PT lesion was identified in 1.6% of TKAs. But, we could not specify whether it was a trans-tendon section or a PT footprint injury.

Risk factors of iatrogenic section of the PT included a shorter distance between the PT and the distal articular surface of the femur [4] and small knees [1]. According to Herregodts [5], the low skill level of the surgeon can be a risk factor. In our case series, all surgeons were experienced. Risk factors for excision of the PT femoral footprint included: female gender [6], a reduced anteroposterior knee diameter [6], a thick resection of the distal femoral condyle [2] and short stature of the patient [2, 3]. According to the cadaveric study of Takahashi *et al*. [6], for certain TKA designs, the femoral footprint of PT can inevitably be excised, regardless of technical problems. According to this study, the LCS system (low contact stress) seemed to preserve the insertion of PT. Apinyankul [3] found that High-flex TKA prosthesis with thicker posterior condyle relates to higher possibility of PT footprint injury compared to standard one.

The effect of PT injury on knee stability after TKA was studied in 6 articles: five cadaveric studies (Table 3) and a randomized blind trial [7].

The findings of the cadaver studies have been contradictory. Three studies concluded that there was no effect on static knee stability after PT section, in both postero-stabilized TKAs [8,9] and TKAs retaining the PCL [10]. According to Kanamya *et al*. [8], a significant effect was noted only when the other postero-lateral structures were sectioned. For Ghosh *et al*. [9], above 90 ° of flexion, the laxity increases significantly. The two other cadaveric studies concluded that the flexion and extension spaces increased significantly medially and laterally after complete section of the PT during postero-stabilized TKA [4] and during TKA retaining the PCL [11]. According to Cottino *et al*. [11], a greater effect was

observed in the lateral compartment both in extension and in flexion. The most statistically significant effect was observed with the knee in flexion. The preservation of the PCL did not prevent the opening of the lateral space after the PT section [11].

In their blinded randomized trial, Kesman *et al*. [7] did not document any difference in the subjective stability of the knee after section of the PT during postero-stabilized TKA. Kesman *et al*. [7] also carried out a cadaveric study on three knees. There was no change in the distribution of charges between the medial and lateral tibial plateau after the PT section when the knee is near the extension. However, they did not assess the effect of the PT section on the knee in flexion. Finally, they concluded that the PT section had no effect on the stability of the knee during TKA.

The effect of iatrogenic lesions of PT on knee function was studied only in the article of De Simone *et al*. [1] and ours. De Simone [1] concluded that a complete intraoperative section of PT resulted in a decrease in IKS functional scores after two to three years postoperatively. Our study found functional scores relatively good, but they were inferior to those of De Simone [1].

It is not clear what effect a repair of the PT would have on the functional results. To our knowledge, there are no publications that have evaluated the results of PT repair during TKA. The case report of Ugutmen *et al*. [12] described a case of lateral dislocation of the knee after TKA following an iatrogenic lesion of the lateral collateral ligament (LCL), the arcuate ligament (AL) and PT. The patient had a trans-bone suture of the PT with a repair of the AL and the LCL. The result was satisfying after 14 months. In our case series, only one patient had a tendon suture. This patient had preoperative varus laxity with a significant varum and he maintained a laxity of less than 10 ° postoperatively. This patient was satisfied with the functional outcome of his TKA.

Limitations

Our study has several limitations. First, the small sample size limits our ability to draw conclusions about the risk factors of iatrogenic PT lesion during TKA. We did, however, note that this complication occurred only in patients having stiff and tight knees with an extension deficit, in which relatively small components were used. Second, we could not specify whether it was a trans-tendon section or a PT footprint injury.

CONCLUSION

During total knee arthroplasty, two types of iatrogenic lesions of the PT can be seen: partial or total transection of the tendon and partial or total resection of its footprint. The risk factors for iatrogenic lesions of PT mentioned in the literature are: female gender, small

knees and thicker resection of the external femoral condyle. The isolated injury of the PT does not seem to affect the static stability of the knee after TKA. However, it can cause a decrease in long-term functional scores. More work is needed to better understand the repercussions of iatrogenic lesions of PT during TKA on the stability of the knee and its function.

What is already known on this topic?

- The popliteus tendon is known to have an important role in the stability of the postero-lateral corner of the knee.
- The role of the popliteus tendon in the stability of the knee after arthroplasty is still controversial.
- The influence of the popliteus tendon injury on knee function after arthroplasty is not yet understood.

What this study adds

- The isolated lesion of the popliteus tendon does not seem to affect the static stability of the knee after TKA.
- Popliteus tendon injury can cause a decrease in long-term functional scores.

Competing interests

The authors declare no competing interests.

Authors' contributions

Ameni Ammar and Oussama Abcha have participated in all phases of this study during proposal preparation, data collection, data analysis and manuscript writing; Selim Ben Jaafar and Marouen Beriri have participated in the manuscript writing. Mahmoud Smida and Mohamed Samir Daghfous contributed in the manuscript revision.

All the authors read and approved the final version of the manuscript.

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