


Total Infrapatellar Fat Pad Excision Leads to Worse Isokinetic Performance in Total Knee Arthroplasty: A Randomized Controlled Trial

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Abstract

There are concerns that total infrapatellar fat pad (IPFP) excision in total knee arthroplasty (TKA) results in patellar tendon shortening due to ischemic contracture, but individual preference of the surgeon is still the main determinant between total or partial excision. The aim of this randomized controlled study was to compare isokinetic performance and clinical outcome of TKAs with total and partial excision of the IPFP. Seventy-two patients scheduled to undergo TKA for primary knee osteoarthritis by a single surgeon were randomly assigned to either total or partial excision group. Patients were evaluated preoperatively and at postoperative 1 year, with Knee Society Score (KSS) and isokinetic measurements. The physiatrist performing isokinetic tests and patients were blinded to the study. There were no significant differences between the groups in respect of age, body mass index, gender, and preoperative KSS and isokinetic performance. Postoperatively, both groups had improved KSS knee and KSS function scores, with no difference determined. Knee extension peak torque was significantly higher postoperatively in the partial excision group at postoperative 1 year ($p = 0.036$). However, there were no significant differences in knee flexion peak torque following TKA ($p = 0.649$). The results of this study demonstrated that total excision of the IPFP during TKA is associated with worse isokinetic performance, which is most likely due to changes in the knee biomechanics with the development of patella baja. Partial excision of the IPFP appears to be a valid alternative to overcome this potential detrimental effect without impeding exposure to the lateral compartment. This is a Level I, therapeutic study.

Keywords

- ▶ infrapatellar fat pad
- ▶ patellar tendon
- ▶ total knee arthroplasty
- ▶ isokinetic test

Exposure for total knee arthroplasty (TKA) commonly includes excision of the infrapatellar fat pad (IPFP). The rationale behind this is to obtain improved access to the lateral tibial plateau allowing a more accurate bone cut,

baseplate placement, and easier management of soft tissue interposition in the bone and cement interface.¹ However, there is growing concern that as the IPFP is a highly vascularized and innervated fibrous adipose tissue filling the

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anterior compartment of the knee, its complete excision may have a detrimental effect on knee biomechanics and ultimately TKA outcome.²⁻⁶ The reason for this effect has been suggested to be patellar tendon (PT) scarring and shortening via ischemic contracture following impaired vascularization, maintenance, and biological repair of the tendon.^{2,3,5}

There are only scarce data available in the literature on the theory of IPFP excision during TKA leading to patellar shortening, which offer contradicting results.⁶ These studies radiographically compared the patellar height in total excision, partial excision, and/or total preservation techniques. Scarring and shortening of the PT leads to patella baja, which has been shown to change the kinematics of the extensor mechanism.⁷⁻⁹ However, effect of this change in kinematics on the isokinetic performance after TKA has not been thoroughly emphasized in the literature. To the best of our knowledge, no prospective randomized controlled study has compared the isokinetic performance of total and partial IPFP excision in TKA. The aim of this randomized controlled trial (RCT) was to compare knee extension and flexion peak torque and the Knee Society Score (KSS) in patients undergoing TKA with total IPFP excision or partial IPFP excision. The hypothesis of the study was that during TKA, total IPFP excision would lead to worse isokinetic performance and clinical outcome.

Materials and Methods

Approval for this study was granted by the Local Ethics Committee and CONSORT (Consolidated Standards of Reporting Trials) guidelines have been followed thereafter. This trial was registered at ClinicalTrials.gov (identifier: NCT04419142). Written and informed consent was obtained from all participants. The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

We assessed eligibility of all patients admitted to our clinic between 55 and 80 years, scheduled to undergo unilateral TKA on for primary knee osteoarthritis. Those with bilateral TKA, inflammatory arthritis, post-traumatic osteoarthritis, insufficiency of collateral ligaments, previous knee surgery, and neuromuscular diseases were excluded. In total, 72 patients were enrolled in the study between July 2017 and October 2018, and enrolled patients were randomized in a 1:1 ratio via computer-generated randomization by using Microsoft Excel 2016 (Microsoft Corporation, Seattle, WA) to be allocated in the total or partial IPFP excision group before the TKA operation. Unblinded senior resident implemented the randomization. Patients and physiatrists performing isokinetic measurements were blinded to group allocation.

All surgeries were performed by the senior surgeon, with cruciate retaining total knee replacements of Vanguard Complete Knee System prosthesis (Zimmer Biomet Inc., Warsaw, IN). A tourniquet was inflated to pressure of 300 mmHg after spinal anesthesia. A straight, longitudinal midline skin incision and medial parapatellar arthrotomy were per-

formed. In the total excision group, the IPFP was completely excised, and in the partial excision group, only the medial border of the fat pad was excised leaving the PT unexposed. In both groups, the patella was retracted and not everted. Both femoral and tibial prostheses were implanted with pressured bone cement. On the morning of the day 1 after surgery, patients were mobilized under supervision of the physiotherapist. All patients underwent the same rehabilitation procedure during the outpatient period, supervised by the same physiotherapist.

The primary outcome was isokinetic performance, measured as peak knee extensor and flexor torque values in Newton-meters, on the operated knee. Measurements were done preoperatively and at 12-month follow-up examination under the supervision of the same physiatrist. Gwyn et al showed significant shortening of PT postoperatively for total excision 1 year postoperatively³ that is why measurements were done at 12 months to examine potential detrimental effects of shortening of the PT. At same time points, the KSS was evaluated as well, which was the secondary outcome. Isokinetic measurements were performed with a Biodex System III Isokinetic Dynamometer, version 3.03 (Biodex Medical Inc., Shirley, NY) by the same senior physiatrist. Patients were positioned on the dynamometer with the hip in 90 degrees in a sitting position for knee flexion and extension measurements. Lateral movement of the knee was prevented during the full extension and flexion of the knee by a thigh strap on the operated leg. The physical therapist helped the patients to achieve proper positioning before each test. Concentric isokinetic knee flexion-extension was assessed at a preset velocity of 60 degrees/sec over a range of motion of 0 to 110 degrees for both parameters. A fixed number of 10 flexion-extension repetitions were completed by each patient. The instructions were provided once more, and one more trial repetition was performed by all patients before the last baseline muscle strength measurements were taken. The estimated intraclass correlation coefficients for the peak extensor torque and peak flexor torque were 0.827 and 0.834, respectively.

Statistical Analysis

Sample size estimation was performed by using the knee extension peak torque as a primary effect variable. As there is no similar study with isokinetic measurements regarding this subject, a difference in mean values of 12 Nm and standard deviation of 15 Nm were assumed for each group. Group sample sizes of 33 and 33 achieved a power of 0.90 to detect a difference of 12 Nm between the two groups with estimated group standard deviations of 15 Nm for each group and with a significance level (α) of 0.05 using a two-sided, two-sample test. Considering loss to follow-up, the number of patients in each group was increased by 10%. Thus, three patients were added to each group and the study included 36 patients in each group. All data for continuous variables were calculated as mean and standard deviation. The Student's *t*-test and the Chi-square test were used for statistical comparison. Data obtained in the study were analyzed

statistically by using SPSS software (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). The α value was set at <0.05 for all statistical tests.

Results

A total of 133 TKAs were screened and, according to the inclusion and exclusion criteria, 72 patients were enrolled in the study initially (**►Fig. 1**). After exclusion of one patient from the total excision group due to deep infection of the knee, the study was completed with 35 patients in the total excision group and 36 patients in the partial excision group. The excluded patient underwent implant removal and spacer application. Other postoperative complications were one superficial infection and two symptomatic deep vein thrombosis which were cured with drug treatment. This one superficial infection was seen in partial excision group and of these two symptomatic deep vein thrombosis, one patient was from excision partial group and one patient was from

Table 1 Patient demographics

	Total excision	Partial excision	p-Value
Gender (n, F/M)	29/6	27/9	0.417
Age (y)	66.57 \pm 10.26	65.78 \pm 9.18	0.732
BMI (kg/m ²)	28.87 \pm 4.14	29.56 \pm 4.70	0.508

Abbreviation: BMI, body mass index.

Note: Continuous variables are presented as mean and standard deviation.

total excision group. The groups were similar in respect of age, gender, and body mass index distribution (**►Table 1**).

There were no significant differences in preoperative isokinetic performance between groups (**►Table 2**). Knee extension peak torque was significantly higher postoperatively in the partial excision group compared with the total excision group at postoperative 1 year ($p = 0.036$); however,

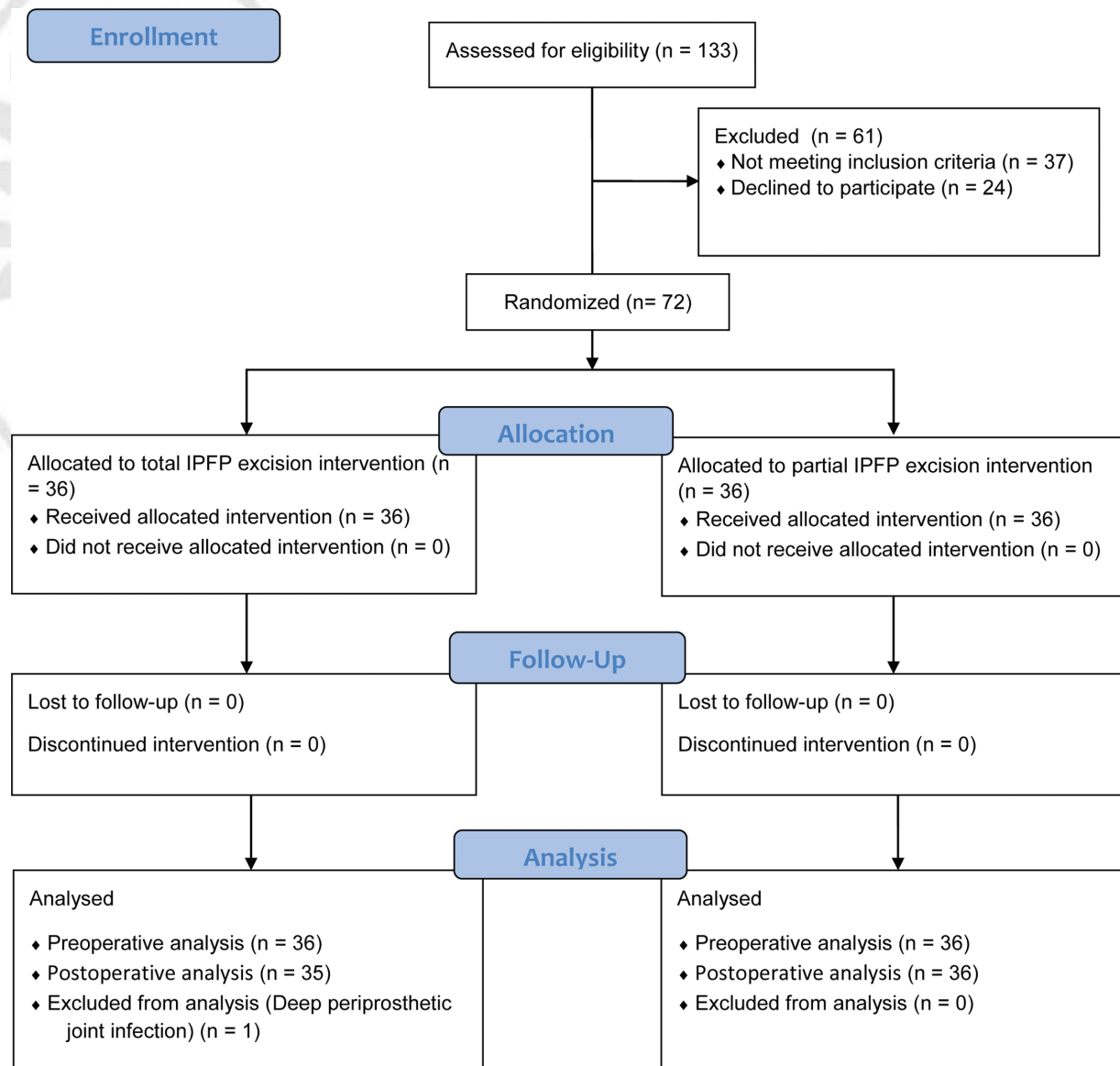


Fig. 1 CONSORT (Consolidated Standards of Reporting Trials) diagram.

Table 2 Knee extensor and flexor peak torque values of the operated knee, preoperatively and 1 year postoperatively in both groups

	Preoperative			1 year postoperative		
	Total excision	Partial excision	p-Value	Total excision	Partial excision	p-Value
Extension torque	57.57 ± 9.33	60.06 ± 9.64	0.274	61.49 ± 10.06	67.50 ± 13.32	0.036
Flexion torque	39.03 ± 8.89	41.22 ± 8.04	0.279	41.69 ± 9.46	42.67 ± 8.63	0.649

Note: Data are presented as mean and standard deviation.

Table 3 Patient-reported outcome (KSS-Knee and KSS-Function) preoperatively and 1 year postoperatively in both groups

	Preoperative			1 year postoperative		
	Total excision	Partial excision	p-Value	Total excision	Partial excision	p-Value
KSS-Knee	49.66 ± 13.72	52.44 ± 12.91	0.381	90.4 ± 4.77	92.08 ± 4.69	0.138
KSS-Function	51.37 ± 15.38	53.97 ± 12.28	0.435	82.43 ± 11.16	84 ± 9.93	0.533

Abbreviation: KSS, Knee Society Score.

Note: Data are presented as mean and standard deviation.

there were no significant difference in knee flexion peak torque following TKA ($p = 0.649$; ► **Table 2**). There were no significant differences in preoperative KSS between groups. Both groups experienced significant improvements in KSS scores at the 1 year follow-up, with no significant difference determined between the groups (► **Table 3**).

Discussion

The results of this study showed that partial IPFP excision during TKA has a favorable effect on isokinetic performance at postoperative 1 year, whereas total excision of the IPFP resulted in reduced knee extension peak torque. Considering that all surgeries were performed by the same surgeon with the same technique using the same implants and similar patient demographics, the only apparent difference between the two groups was the approach to IPFP during TKA. Therefore, it seems plausible to assume that total excision of the IPFP can cause ischemic contracture in PT, thus leading to worse quadriceps function. To the best of our knowledge, this detrimental effect of total IPFP excision on isokinetic performance has not been previously investigated in the literature. Both groups experienced a substantial clinical benefit demonstrated by the results of KSS, as defined in the study by Lizaur-Utrilla et al¹⁰; however, there was no difference between the groups after 1 year. This may be due to reduced pain sensation following total excision of the IPFP, which is known to be structure rich in sensory nerves.

Everyday experience of TKA usually includes total IPFP excision to obtain better exposure of the lateral compartment. Furthermore, there is a scientific basis to assume that the IPFP has an important role in pain sensation via branches from the femoral, saphenous, obturator, and sciatic nerves that run through it.¹¹ However, in a 2013 systematic review, Van Beeck et al reported conflicting evidence on the association of IPFP preservation with anterior knee pain.⁶ Despite concerns about the preservation of the IPFP, recent studies

have suggested that total excision of the IPFP may not be the optimal technique due to its suggested protective role on PT.^{12,13} Cadaver studies have demonstrated a rich blood supply through anastomoses supplying PT.^{14,15} Therefore, impaired maintenance, healing and ischemic contracture of the tendon can be expected following total excision.

Despite the theories, clinical translation of the aforementioned role of the IPFP remains controversial and varying methodologies in related studies have resulted in unreliable literary output. Van Beeck et al included the highest quality studies on IPFP excision in TKA in their systemic review and still could not demonstrate strong evidence for pain, PT shortening, and function.⁶ In a contemporary study, Gwyn et al evaluated the effect of partial and total excision of the IPFP during TKA and showed significant shortening of PT postoperatively for total excision 1 year postoperatively.³ Those results are more reliable than similar studies in the literature, as the postoperative change in PT length was isolated by omitting the effect of the change in joint morphology following surgery. Literature cannot provide clear conclusions based on results from these meta-analysis and research studies and therefore optimal strategy for IPFP excision in routine practice remains unknown.

Quadriceps muscle strength is an important predictor of functional abilities in patients undergoing TKA.¹⁶ Isokinetic testing has been shown to be a practical method which is able to reliably assess quadriceps strength in patients after TKA. Therefore, it is commonly used in both clinical practice and research settings.¹⁷ In current study, isokinetic testing was used as an objective parameter to evaluate functional differences between the two groups. PT torque is defined as the torque generated at the center of rotation of the knee by the force in the PT and is dependent on the PT moment arm.^{18,19} Patellar congruence and position are critical in quadriceps function as the patella acts as a lever arm altering the magnitude and direction of the quadriceps tendon and as a spacer increasing the extension moment arm, ultimately

mechanically aiding knee extension.⁸ A recent study demonstrated via a computational musculoskeletal model of the knee that patella baja significantly decreases the PT moment arms in flexed knee postures, translating to sit-to-stand or squat-to-stand movements.²⁰ In such cases, to maintain the necessary extension torque, the quadriceps would need to generate stronger contractions, which can lead to anterior knee pain, impingement of the patella against tibial components, patellar component wear and loosening, further PT degeneration and PT or quadriceps tendon tears.⁷

There are some limitations to this study. First, the patients in the present study had primary knee osteoarthritis and cases of knee osteoarthritis secondary to other disorders such as rheumatological disorders were not evaluated. Second, many cofounding factors on TKA outcome such as nutrition, chronic diseases, and smoking status were not recorded, which may have had an independent effect on clinical outcome. Additionally, patellofemoral joint problems were not taken into consideration in the current study. Finally, a radiographic analysis was not included in the study. However, as this was a single surgeon study, it seems safe to expect no difference in radiographic outcome, which would not significantly alter the results.

Conclusion

In conclusion, the results from this randomized controlled study imply that total excision of the IPFP during TKA places the patient at risk of worse isokinetic performance which can lead to an inferior ultimate outcome. We recommend that partial IPFP excision instead of total should be considered in TKA.

Funding

None.

Conflict of Interest

None declared.

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