Arthroplasty Today 23 (2023) 101175

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Original Research

Resident Impact on Primary Total Knee Arthroplasty: A Consecutive Series Under a Single Surgeon

Justin A. Stafford, DO, MS [a,*], Paul DeVito, DO [a], Gagan Grewal, MD [a], Ty A. Davis, DO [a], Christopher Guerra, DO [b], Arturo Corces, MD [a]

[a] Larkin Hospital Department of Orthopaedic Surgery, South Miami, FL, USA
[b] Lake Erie College of Medicine, Bradenton, FL, USA

ARTICLE INFO

Article history:
Received 5 March 2023
Received in revised form
6 June 2023
Accepted 20 June 2023
Available online xxx

Keywords:
Infection
Orthopaedic residency
Prosthetic joint infection
Surgeon training
Total knee arthroplasty

ABSTRACT

Background: The literature has displayed conflicting evidence on resident involvement in surgical procedures. The goal of this study was to assess the impact of resident involvement on primary total knee arthroplasty (TKA) under a single fellowship-trained adult reconstruction surgeon.
Methods: Two hundred sequential patients were retrospectively reviewed by a single surgeon: the first cohort represented the final 100 TKAs performed by the surgeon without resident involvement (NRI), serving as the control group, and the second cohort represented the initial 100 TKAs performed by the same surgeon with resident involvement (RI), serving as the experimental group. Perioperative variables such as number of people in operating room (OR), surgical time, and tourniquet time, and postoperative variables such as infection, minor complications, medial distal femoral angle, medial proximal tibia angle, and total angulation were assessed.
Results: The rate of infection was significantly lower in the RI group (0%) compared to the NRI group (1%) ($P = .043$). The number of staff in the OR ($P < .001$), the tourniquet time ($P < .001$), and OR time ($P < .001$) were significantly higher in the RI group compared to the NRI group. There was no difference in coronal plane radiographic measurements: medial distal femoral angle ($P = .10$), medial proximal tibia angle ($P = .19$), or total angulation ($P = .27$).
Conclusions: Resident involvement in primary TKA neither demonstrated any significant difference in coronal plane radiographic alignment of the prosthesis nor an increased risk of infection despite increased operative time, tourniquet time, and number of people in OR.
Level of evidence: Level 3 - Therapeutic retrospective cohort study.

Introduction

Primary total knee arthroplasty (TKA) is projected to increase in demand by 143% by the year 2050 [1]. Further, estimates project the financial burden of prosthetic joint infection to be nearly $2 billion by the end of the current decade [2]. Therefore, it is incumbent on training programs to concomitantly provide training for future arthroplasty surgeons and satisfactory patient outcomes.

As the rates of primary TKA continue to rise, these procedures impact a greater number of the population. Resident involvement should not portend higher rates of complications. The literature has displayed conflicting evidence on resident involvement in surgical procedures. Previous studies have shown increase in total operative time, increase in sepsis, and trends toward increase in medical complications with resident involvement (RI) in primary TKA [3]. Conversely, other studies have demonstrated no difference in patient outcomes, length of hospital stay, or operative time with RI under PGY-5 [4]. There are varying theories on the correct alignment options of TKA including mechanical alignment (MA), kinematic alignment, anatomic alignment, and variations of these with success can be dependent on patient-specific parameters and surgeon expertise using a preferred method [5].

Radiographic parameters are important to assess with RI such as coronal plane alignment of the femoral and tibial component using medial distal femoral angle (MDFA) and medial proximal tibia angle

* Corresponding author. Department of Orthopaedics, Larkin Community Hospital, 11801 SW 90th Street #201, Miami, FL 33186, USA. Tel.: +1 937 307 9020.
E-mail address: justin.stafford111@gmail.com

https://doi.org/10.1016/j.artd.2023.101175

(MPTA) to assess placement [6]. Using MA with standard total knee systems, many surgeons opt for a 5° valgus distal femoral resection and a 0° proximal tibia resection for implant positioning to restore MA. Radiographically, this would create a MDFA of 95° from the long axis of the femur and a 90° MPTA from the long axis of the tibia.

Further evidence is needed to determine the impact of perioperative and postoperative parameters of primary total knee arthroplasties with RI.

The goal of this study was to assess the impact of resident involvement on primary TKA under a single fellowship-trained adult reconstruction surgeon. We hypothesize that resident involvement will increase operative time but will not impact rates of radiographic malalignment, reoperation, or complication [7].

Material and methods

Following institutional review board approval (IRB# LCH-4-042021), a retrospective cohort review of 200 consecutive primary TKA cases performed by a single fellowship trained surgeon from October 2019 to December 2020 were collected. Patients were grouped into the following 2 cohorts: the first cohort represented the final 100 TKAs performed by the surgeon without resident involvement (NRI), serving as the control group, and the second cohort represented the initial 100 TKAs performed by the same surgeon with RI, serving as the experimental group. Inclusion criteria for patients were >18 years of age undergoing a primary TKA for osteoarthritis who received a cruciate retaining implant (Fig. 1). Exclusion criteria included patients under the age of 18 years, varus or valgus angulation greater than 20°, and patients undergoing revision TKA. Varus and valgus angles greater than 20° may require varying techniques in alignment for osseous alignment, soft tissue balancing, and use of constrained implants. As the vast majority of TKAs performed by the surgeon involved in this study performs MA, it was chosen to exclude these patients.

Collected data included patient demographics, perioperative variables, postoperative values, and postoperative outcomes. Patient demographics included age, gender, and body mass index (BMI). Perioperative variables included the number of staff in the operating room (OR), total OR time, and tourniquet time. Postoperative outcomes were rates of minor complications and infection. Minor complications included superficial infection or peri-incisional compromise. Infections were categorized as prosthetic joint infection necessitating either debridement, antibiotics, and implant retention procedure or formal 2-stage revision.

Radiographic evaluation

Postoperative radiographs were reviewed by 2 authors for MDFA and MPTA. These measurements evaluated the coronal plane position of the component relative to the longitudinal axis of its corresponding bone. The MDFA was made by connecting points at the distal medial and distal lateral aspects of the femoral component and a line parallel to the longitudinal axis of the femur (Fig. 2a). The MPTA was made by connecting points at the proximal medial and proximal lateral aspects of the tibial baseplate and a line parallel to the longitudinal axis of the tibia (Fig. 2b).

Statistical analysis

The data was found to be normally distributed; therefore, means were compared with independent Student t-test for all numerical variables. Chi-square tests or Fisher's exact tests were used to compare categorical variables. All tests were two-tailed, and a *P* value of less than .05 was considered statistically significant.

Results

The term of follow-up was 14 months for the consecutive series of 200 primary TKAs. There were no significant differences in

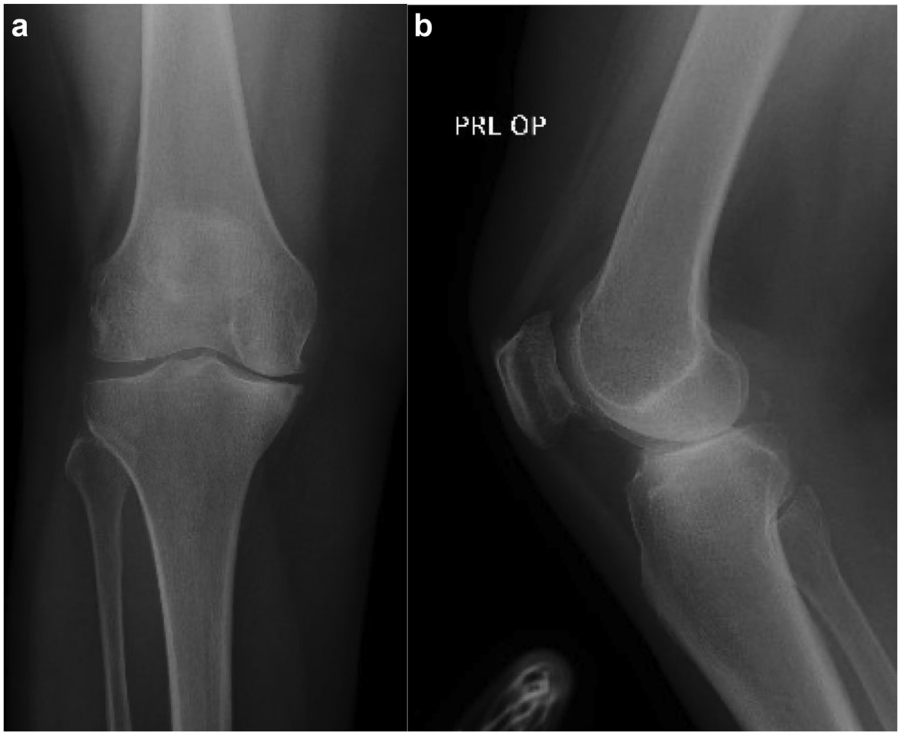

Figure 1. (a) Anteroposterior and (b) lateral radiograph of right knee indicated for primary total knee arthroplasty.

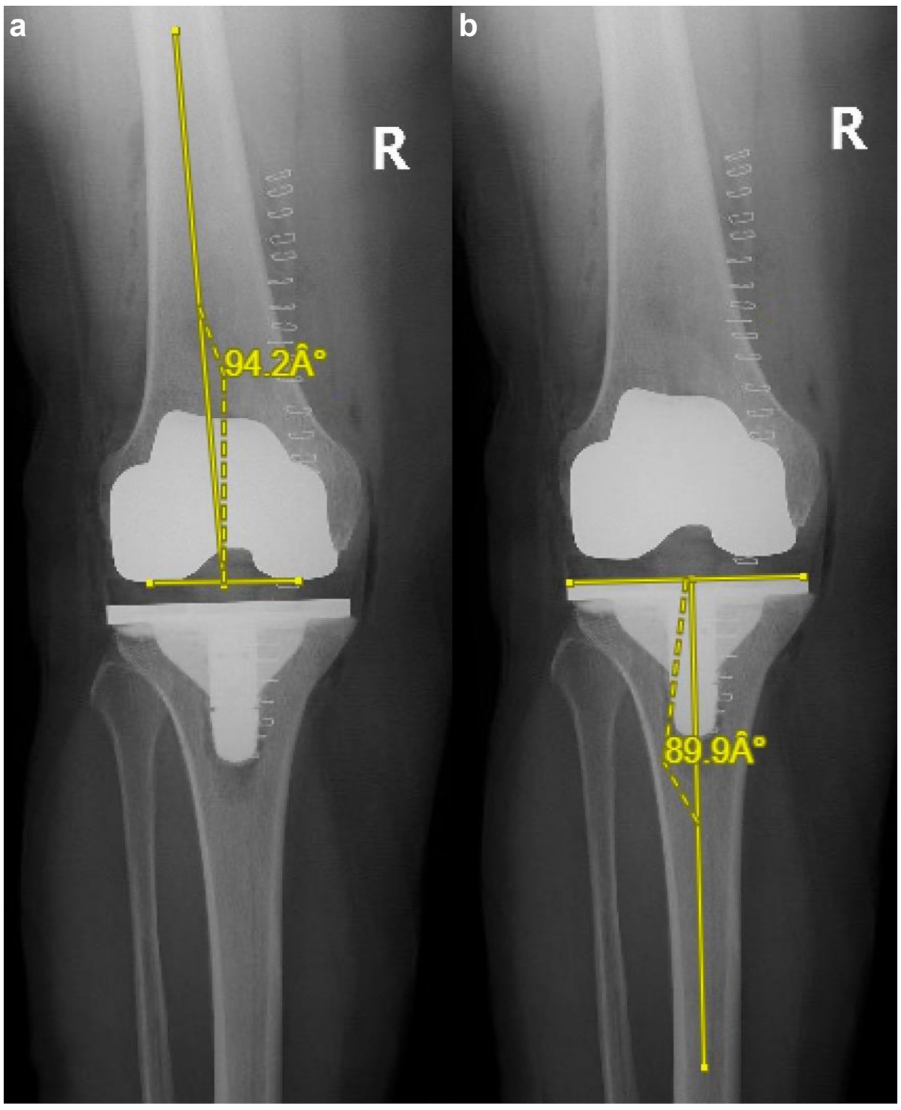

Figure 2. Anteroposterior radiographic case example of radiographic measurement for the (a) medial distal femoral angle (b) medial proximal tibial angle.

demographic data age 70.2 RI vs 72.4 NRI, 74% female RI vs 77% female NRI, and 30.2 BMI RI vs 31.5 BMI NRI. (Table 1). There was a significant difference in perioperative variables (Table 2): 8.9 people in OR with RI vs 7.1 people in room NRI ($P < .001$), OR time was 159 minutes with RI and 118 minutes with NRI ($P < .001$), and tourniquet time was 86 minutes with RI and 56 minutes with NRI ($P < .001$). Postoperative variables showed no significant difference in coronal plane radiographic measurements (Table 3) between the 2 groups: MDFA with RI 93.4° vs 94.0° with NRI ($P = .10$), MPTA 88.9° with RI and 88.2° with NRI ($P = .19$), total angulation 181.6° with RI and 182.9° with NRI ($P = .27$). There was a lower rate of deep infection with RI 0% vs 1% with NRI. There was no difference in other complications: 2% with RI and 5% with NRI ($P = .24$).

Discussion

This study demonstrates that resident involvement did not negatively impact infection rate or coronal plane radiographic alignment in primary TKA. There is an expectation for longer tourniquet time and OR time with RI, and our data confirms this premise. Although prior studies have described longer OR time leading to increased risk of infection [7,8], our results did not support this finding, as rates of infection were not significantly different among the 2 cohorts.

Our results have important implications given the continued projections for increasing rates of primary TKAs. With numerous techniques, approaches, implants, robotics, and navigation-assisted

Table 1
Preoperative patient demographics.

Patient demographics			
Category	With residents	Without residents	Significance
Age[a]	70.2	72.4	$P = .089$
Gender	74% female	77% female	$P = .62$
BMI	30.2	31.5	$P = .07$

[a] Age measured in years.

Table 2
Perioperative variables.

Perioperative variables			
Category	With residents	Without residents	Significance ($P < .05$)
People in OR	8.9	7.1	***P* < .001**
OR time	159 min	118 min	***P* < .001**
Tourniquet time	86 min	56 min	***P* < .001**

Table 3
Postoperative variables.

Postoperative variables			
Category	With residents	Without residents	Significance ($P < .05$)
MDFA	93.4°	94.0°	$P = .10$
MPTA	88.2°	88.9°	$P = .19$
Total angulation	181.6°	182.9°	$P = .27$
infection	0%	1%	***P* = .04**
Minor complications	2%	5%	$P = .24$

surgery, it is important to understand the learning curve associated with primary TKA. Previously studied research has helped to identify and acknowledge these learning curves with emphasis on outcomes [9]. These learning curves have been shown to decrease over time with larger case volumes and radiographic alignment comparable to that of a senior arthroplasty surgeon [10,11]. The current findings demonstrate that resident involvement did not significantly impact coronal plane radiographic alignment of the prosthesis.

Another factor to consider with RI in primary TKA is patient outcomes. Storey et al. performed a retrospective review of primary total knee and unicompartmental knee arthroplasties to assess if the involvement of orthopaedic residents had an impact on implant survival and functional outcomes measured by the Oxford knee score. In terms of the TKAs, there was no significant difference between implant survival, an actual lower revision rate with supervised junior residents, and no difference in functional outcomes [12]. Our results demonstrate that resident involvement cohort had longer operative times with a decrease in infection rates compared to the nonresident involvement cohort, which had shorter operative times.

Limitations

The retrospective methodology is an inherent limiting factor. Additionally, the inclusion of patient-reported outcomes may improve the applicability of the conclusion, as previous studies demonstrate improvement in patient outcomes with better alignment of the components [13]. Although results from a single surgeon strengthen the reliability of the data, it may reduce the generalizability. However, comparison of groups within a consecutive patient series limits confounding factors such as surgeon experience, implant use, and factors related to the surgical setting.

Conclusions

Resident involvement in primary TKA did not increase the risk of infection or radiographic malalignment. The increase in operative time for RI did not result in a higher rate of infection compared to a shorter operative time for NRI.

Conflicts of interest

The authors declare there are no conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2023.101175.

References

[1] Inacio MCS, Paxton EW, Graves SE, Namba RS, Nemes S. Projected increase in total knee arthroplasty in the United States – an alternative projection model. Osteoarthritis Cartilage 2017;25:1797–803. https://doi.org/10.1016/j.joca.2017.07.022.

[2] Premkumar A, Kolin DA, Farley KX, Wilson JM, McLawhorn AS, Cross MB, et al. Projected economic burden of periprosthetic joint infection of the hip and knee in the United States. J Arthroplasty 2021;36:1484–1489.e3. https://doi.org/10.1016/j.arth.2020.12.005.

[3] Haughom BD, Schairer WW, Hellman MD, Yi PH, Levine BR. Does resident involvement impact post-operative complications following primary total knee arthroplasty? an analysis of 24,529 cases. J Arthroplasty 2014;29:1468–1472.e2. https://doi.org/10.1016/j.arth.2014.02.036.

[4] Bao MH, Keeney BJ, Moschetti WE, Paddock NG, Jevsevar DS. Resident participation is not associated with worse outcomes after Tka. Clin Orthop Relat Res 2018;476:1375–90. https://doi.org/10.1007/s11999.0000000000000002.

[5] Rivière C, Iranpour F, Auvinet E, Howell S, Vendittoli PA, Cobb J, et al. Alignment options for total Knee Arthroplasty: a systematic review. J Orthop Traumatol Surg Res 2017;103:1047–56. https://doi.org/10.1016/j.otsr.2017.07.010.

[6] Theelen L, Bischoff C, Grimm B, Heyligers IC. Current practice of Orthopaedic Surgical Skills training raises performance of supervised residents in total knee arthroplasty to levels equal to those of orthopaedic surgeons. Perspect Med Educ 2018;7:126–32. https://doi.org/10.1007/s40037-018-0408-y.

[7] Naranje S, Lendway L, Mehle S, Gioe TJ. Does operative time affect infection rate in primary total knee arthroplasty? Clin Orthop Relat Res 2015;473:64–9. https://doi.org/10.1007/s11999-014-3628-4.

[8] Ravi B, Jenkinson R, O'Heireamhoin S, Austin PC, Aktar S, Leroux TS, et al. Surgical duration is associated with an increased risk of periprosthetic infection following total knee arthroplasty: a population-based retrospective cohort study. EClinicalMedicine 2019;16:74–80. https://doi.org/10.1016/j.eclinm.2019.09.015.

[9] Nzeako O, Back D. Learning curves in Arthroplasty in orthopedic trainees. J Surg Educ 2016;73:689–93. https://doi.org/10.1016/j.jsurg.2016.02.006.

[10] Hoerlesberger N, Glehr M, Amerstorfer F, Hauer G, Leithner A, Sadoghi P. Residents' learning curve of total knee arthroplasty based on radiological outcome parameters: a retrospective comparative study. J Arthroplasty 2021;36:154–9. https://doi.org/10.1016/j.arth.2020.07.045.

[11] Goto K, Katsuragawa Y, Miyamoto Y. Outcomes and component-positioning in total knee arthroplasty may be comparable between supervised trained surgeons and their supervisor. Knee Surg Relat Res 2020;32. https://doi.org/10.1186/s43019-019-0018-y.

[12] Storey R, Frampton C, Kieser D, Ailabouni R, Hooper G. Does orthopaedic training compromise the outcome in knee joint arthroplasty? J Surg Educ 2018;75:1292–8. https://doi.org/10.1016/j.jsurg.2018.02.011.

[13] Lotke PA, Ecker ML. Influence of positioning of prosthesis in total knee replacement. J Bone Joint Surg 1977;59:77–9. https://doi.org/10.2106/00004623-197759010-00013.