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Original Research

Fellowship Training in Arthroplasty Improves Treatment Success of Debridement, Antibiotics, and Implant Retention for Periprosthetic Knee Infections

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ABSTRACT

Background: Debridement, antibiotics, and implant retention (DAIR) is a well-accepted surgical strategy for periprosthetic joint infection (PJI) following total knee arthroplasty (TKA). DAIR in TKA may be incorrectly thought of as a "simple" procedure not requiring formal specialized training in arthroplasty. Currently, there are no studies comparing the risk of treatment failure based on surgeon fellowship training.

Methods: A retrospective review was performed of consecutive patients who underwent DAIR for TKA PJI at our institution. Two cohorts were created based on whether DAIR was performed by an arthroplasty fellowship-trained (FT) surgeon or nonarthroplasty fellowship-trained (NoFT) surgeon. Primary outcome was treatment failure following DAIR at a minimum of 1 year postoperatively. Treatment failure was based on the Tier 1 International Consensus Meeting definition of infection control. Secondary outcomes were also recorded including death during the totality of PJI treatment.

Results: A total of 112 patients were identified (FT = 68, NoFT = 44). At a mean follow-up of 7.3 years [standard deviation = 3.9], 73 patients (59.8%) failed treatment. Fellowship training in arthroplasty significantly improved treatment success rates (FT, 35/68 [51.5%]; NoFT, 10/44 [22.7%]; odds ratio 2.5 [95% confidence interval 1.1 to 5.9; $P = .002$]). Survivorship also differed significantly between the cohorts; at timepoints of 1.5 months, 5 months, 30 months, and 180 months, survivorship of the FT cohort was 79.4%, 67.6%, 54.4%, and 50.7%, respectively, compared with a survivorship of 65.9%, 52.3%, 25%, and 22.7% in the NoFT cohort ($P = .002$).

Conclusions: TKA PJI treated with DAIR should not be considered a simple procedure. Improved treatment success may be associated with subspecialty fellowship training in arthroplasty.

Level of Evidence: IV.

Introduction

Total knee arthroplasty (TKA) is one of the most performed elective orthopaedic procedures, and the surgical volume is projected to keep increasing in step with the aging demographics of the population [1,2]. Despite improved infection prevention protocols, periprosthetic joint infection (PJI) continues to be a leading cause of revision arthroplasty [3]. Such infections result in persistent pain and lasting functional deficits and are associated with reduced quality of life [4,5].

Contemporary evidence-based clinical practice guidelines for treating periprosthetic knee infections were outlined during the most recent International Consensus Meeting (ICM) on

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Musculoskeletal Infections [6,7]. Open debridement, antibiotics, and implant retention (DAIR) is an accepted surgical strategy for early-onset and acute hematogenous TKA PJI if the implants are well-fixed, no sinus tract exists, and there is a viable antimicrobial therapy that targets the culprit pathogen [7,8]. Some proposed advantages of DAIR include a reduced surgical burden given that it is a less disruptive intervention, shorter operative time, shorter hospital length of stay, lower costs, and improved functional outcomes [9-14]. A recent meta-analysis estimated the infection control rate of DAIR performed for periprosthetic knee infection ranged from 11.1%-100% with an overall pooled estimate of 61.4% (95% confidence interval [CI], 57.3-65.4) [15]. Despite the variability in treatment success rates, DAIR continues to be routinely used as the initial treatment for acute hematogenous and early postoperative TKA PJI.

Several studies have evaluated risk factors associated with the treatment success of DAIR for TKA PJI [16-18] . To date, there are no studies comparing the risk of treatment failure of DAIR for TKA PJI based on surgeon subspecialty fellowship training.

The aims of this study were to assess our center's experience with DAIR as an initial treatment for TKA PJI and determine whether fellowship training in arthroplasty improved treatment success.

Material and methods

Study design

This is an Institutional Review Board approved retrospective cohort study of patients who underwent a DAIR in the context of an early-onset ($\leq$6 weeks from index surgery) [19] or acute hematogenous (<4 weeks of symptoms) [6] periprosthetic knee infection at an academic, tertiary-referral center between 1996 and 2019. All the patients included in this study had primary TKA implants. Revision TKAs and tumor prostheses were excluded. The hospital's PJI database was queried to identify patients with a minimum 1-year follow-up, or until death related to their PJI admission. All DAIRs performed were included, apart from debridements where exchange of the modular components was not performed (2 DAIRs without modular component exchange were excluded; all polytibia components were not encountered in our cohorts). Similarly, any arthroscopic irrigation and debridements were excluded from this study (4 were excluded) [20]. The resultant group of patients was then divided into 2 cohorts based on whether DAIR was performed by a fellowship-trained (FT) arthroplasty surgeon or non-arthroplasty fellowship-trained (NoFT) surgeon. Fellowship training was selected over surgical volume, as PJI represents an uncommon problem with relatively low incidence. As such, fellowship training may represent a better metric than simply assessing surgical case volume [21,22]. Only patients satisfying the criteria for either early-onset ($\leq$6 weeks from index surgery) or acute hematogenous (<4 weeks of symptoms) PJI following primary TKA were included. This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines [23].

Study participants and data collection

Baseline patient demographics were collected including age, sex, body mass index, medical comorbidities, and the American Society of Anesthesiologists score. Additionally, preoperative inflammatory markers (erythrocyte sedimentation rate [ESR] and C-reactive protein [CRP]) were recorded. Data that was required for the purposes of this study were retrospectively collected through manual review of patients' electronic medical records. On review of our data, there were 18 patients missing CRP data with 6/44 (13.6%) missing in the NoFT group and 12/68 (17.6%) missing in the FT group. There were 14 patients missing ESR data with 4/44 (9.09%) in the NoFT group and 10/68 (14.7%) in the FT group.

Surgical strategy

Initial DAIRs for TKA PJI were carried out by 25 orthopaedic surgeons: 9 were fellowship-trained in arthroplasty. The type and quantity of irrigation solution used intraoperatively, as well as the technique used in performing a synovectomy and debridement, varied according to the operating surgeon and is therefore a reflection of each surgeon's skillset and perspective while accounting for patient characteristics. However, all patients included underwent an exchange of the polyethylene liner. All cases that followed the publication of the diagnostic criteria proposed by the Musculoskeletal Infection Society (MSIS) satisfied the diagnosis of PJI [24,25]. Cases that preceded MSIS criteria were reviewed retrospectively to ensure that PJI diagnosis was met. DAIR procedures were performed as added procedures at the end of elective days as well as on-call by both NoFT and FT surgeons. Surgical details including PJI acuity (early-onset vs acute hematogenous), duration of PJI symptoms, laterality, blood transfusion count, and causative microorganism(s) including antimicrobial resistance were collected.

Microbiology

In all cases, $\geq$3 tissue samples were obtained early in the operation to minimize the risk of contamination. Once samples were obtained (tissue and synovial fluid), intravenous antibiotics were administered. Perioperative antibiotic prophylaxis was discussed preoperatively with an infectious disease specialist. In cases where the culprit pathogen was unknown at the time of surgery, either a weight-based dose of cefazolin or vancomycin was given based on preoperative patient risk factors for methicillin-resistant staphylococcal infections [26]. Postoperative antibiotic selection, route of administration, and duration of therapy were decided in consultation with infectious diseases specialists upon finalizing microbiology. Causative pathogens were categorized as: 1) methicillin-sensitive Staphylococcus aureus, 2) methicillin-resistant S. aureus, 3) coagulase-negative staphylococci (CoNS), 4) Streptococcus species, 5) Enterococcus species, 6) other gram-positive microorganisms, 7) Escherichia coli, 8) other gram-negative microorganisms, 9) polymicrobial cultures, and 10) culture-negative PJI. High-failure-risk infections were characterized as follows: methicillin-resistant S. aureus, enterococcus species, gram-negative organisms, and fungal and polymicrobial infections [27-30]. Comparison between cohorts for such infections at elevated risk of failure was performed. No pseudomonas or yeast isolates were noted in this study.

Outcome measures

Primary outcome was treatment failure following DAIR at a minimum of 1 year postoperatively. Treatment failure was defined as including one or more of the following: 1) death directly related to PJI; 2) reinfection confirmed with at least 1 positive aspirate or intraoperative sample; 3) revision surgery for any cause excluding trauma, with repeat DAIR greater than 7 days since initial DAIR considered as failure; and 4) requirement for long-term antibiotic suppression at follow-up to control disease as decided by an orthopaedic surgeon and infectious disease specialist. This was based on the ICM definition of infection control following staged revisions. Our primary outcomes were focused on the Tier 1

definition of success based on infection control with no continued antibiotic therapy. Failure of treatment based on the Tier 2-4 definitions (2: infection control with the patient on suppressive antibiotic therapy, 3: need for reoperation and/or revision and/or spacer retention, and 4: death with a focus on ≤1 year from the initiation of PJI treatment) [6,7,16,24,25,31-34]. Chronic suppression was deemed a failure in this historical cohort due to these DAIRs being performed on PJI in primary TKAs for the first time. Secondary outcomes recorded included death during the totality of PJI treatment and, for those patients who failed initial DAIR, the need for eventual soft tissue reconstruction or amputation. Cause of death and infection status at the time of death was established following a manual review of the patients' electronic medical records at the time of death [26].

Statistical analysis

Data was summarized using descriptive statistics including counts, percentages, and means. Standard deviations were similarly calculated. Parametric tests were selected after an assessment of normal distribution. Chi-square ($\chi 2$) tests were used for categorical variable analyses. Independent samples T-tests were performed to compare continuous variables between the cohorts. A *P*-value of < .05 was considered statistically significant. Survivorship was calculated using a Kaplan-Meier survivorship analysis. All analyses were performed using IBM SPSS (IBM Corp, Armonk, NY) software for Mac (Version 28).

Results

A total of 112 patients were identified to have undergone DAIR as the initial treatment of early-onset or acute hematogenous PJI following elective, primary TKA during the study period. A mean follow-up of 7.3 ± 3.0 years was noted for the entire study population. Fifty-four patients (48.2%) were male, and the average age of the whole cohort was 66.5 ± 10.0 years. Sixty-eight patients (60.7%) were treated by FT. No significant differences were observed between cohorts with regard to baseline patient characteristics including age, sex, body mass index, inflammatory markers, and the American Society of Anesthesiologists score. Similarly, no difference was observed between FT and NoFT with regard to the proportion of early-onset (16/68 [23.5%]) vs (9/44 [20.5%]) and acute hematogenous (52/68 [76.5%]) vs 35/44 (79.5%), respectively PJIs ($P = .70$). Moreover, the duration of symptoms prior to DAIR was similar between cohorts (FT = 6.0 ± 6.9 days vs 7.4 ± 9.6 days, $P = .46$). Reliable capture of symptom onset (SO) (charting of the exact date of onset) was found in 79/112 patients with 34/44 and 45/68 in the NoFT and FT groups, respectively. In the 33 cases, where an exact date of SO was unavailable, their charts indicated a range of dates never exceeding 7 days. We could, therefore, reliably confirm that none exceeded >4 weeks of SO. Complete baseline patient demographics and surgery characteristics are presented in Tables 1 and 2, respectively. Microbiological profiles for each cohort are listed in Table 2. No significant difference was found between the microbiological profiles of both cohorts, including in the proportion of organisms at high risk of failure between cohorts (FT = 10/68 [14.7%], NoFT = 6/44 [13.6%], $P = .87$).

At a mean follow-up of 7.3 years, 67 patients (59.8%) failed treatment of their PJI. Surgeries performed by FT had greater chances of overall treatment success compared to NoFT (FT, 35/68 [51.5%]; NoFT, 10/44 [22.7%]; odds ratio [OR] 2.5, 95% CI 1.1 to 5.9; $P = .002$). Moreover, a trend toward higher mortality during the totality of PJI care was observed for patients treated by NoFT surgeons (FT, 11/68 [16.1%]; NoFT, 13/44 [29.5%]; OR 2.2, 95% CI 0.9 to 5.4; $P = .09$). There were 2 recorded deaths ≤1 year from the initiation of PJI treatment ($P = .754$). No difference in reoperation rate (FT, 22/68 [32.3%]; NoFT, 20/44 [45.5%]; $P = .16$) or need for postoperative suppressive antibiotic therapy (FT, 10/68 [14.7%]; NoFT, 13/44 [29.5%]; $P = .057$) was observed between cohorts. No significant differences were observed regarding the need for soft-tissue reconstruction (FT, 5/68 [7.35%]; NoFT, 1/44 [2.27%]; $P = .24$) or amputation (FT, 2/68 [2.97%]; NoFT, 1/44 [2.27%]; $P = .83$) between cohorts (Tables 3 and 4).

With the numbers available, there were no differences in failure rates between the cohorts during 1996-2012 (FT, 12/21 [57.1%]; NoFT, 14/16 [87.5%]; $P = .07$). There was a significant difference in treatment failure between the cohorts during 2013-2018 (FT, 21/47 [44.7%]; NoFT, 20/28 [71.4%]; $P = .02$) (Table 5).

The Kaplan-Meier survivorship analysis revealed a statistically significant survivorship in the FT cohort. At timepoints of 1.5 months, 5 months, 12 months, 30 months, and 180 months, the survivorship of the FT group was 79.4%, 67.6%, 58.8%, 54.4%, and 50.7%, respectively. This is in comparison to the NoFT group with survivorships of 65.9%, 52.3%, 29.5%, 25%, and 22.7% at the same time points (Log Rank = 0.002) (Fig. 1).

Discussion

The results of this study are the first to highlight the effect of fellowship training on the success rates of PJI treatment following DAIR. Most notably, patients undergoing DAIR for TKA PJI were more than twice as likely to experience treatment success than those treated by NoFT surgeons. Furthermore, a trend toward lower

Table 1
Baseline patient characteristics.

Baseline patient characteristics	Total	FT	NoFT	*P*-value
	N = 112	N = 68	N = 44	
Age, years (SD)	67.8 (11.3)	66.5 (10.0)	69.1 (12.6)	.075
Sex, n (%)				
Female	58 (51.7)	37 (54.4)	21 (47.7)	.489
Male	54 (48.2)	31 (45.6)	23 (52.3)	
BMI, kg/m^2 (SD)	32.1 (7.71)	32.3 (8.02)	31.9 (7.40)	.411
ASA, n (%)				
1	2 (1.87)	2 (3.03)	0 (0.0)	.234
2	19 (17.7)	15 (7.57)	4 (9.75)	
3	65 (60.7)	36 (54.5)	29 (70.7)	
4	21 (19.6)	13 (19.7)	8 (19.5)	
Erythrocyte sedimentation rate, mm/hr (SD)	58.9 (35.65)	55.4 (37.7)	62.4 (33.6)	.170
C-reactive protein, mg/L (SD)	109.7 (87.2)	103.8 (73.2)	115.7 (101.3)	.277

BMI, body mass index; ASA, American Society of Anesthesiologists; SD, standard deviation.

Table 2
Baseline surgical characteristics.

Baseline surgical characteristics	Total	FT	NoFT	*P*-value
	N = 112	N = 68	N = 44	
Follow-up, years (SD)	7.3 (3.0)	7.7 (3.9)	6.9 (3.9)	.153
Time between index and DAIR n (%)				
Early-onset (<6 wk from index)	25 (22.3)	16 (23.5)	9 (20.5)	.700
Acute hematogenous (<4 wk SO)	87 (77.7)	52 (76.5)	35 (79.5)	
Duration of symptoms (d)	6.6 (8.1)	6.0 (6.9)	7.4 (9.6)	.460
Laterality, n (%)				
Left	57 (50.9)	34 (50.0)	23 (52.3)	.814
Right	55 (49.1)	34 (50.0)	21 (47.7)	
Blood transfusion (SD)	0.53 (1.39)	0.50 (1.55)	0.57 (1.23)	.403
Organisms at high risk of failure, n (%)	16 (14.3)	10 (14.7)	6 (13.6)	.874
Causative pathogens, n (%)				
Methicillin-susceptible Staphylococcus aureus	30 (26.8)	18 (26.5%)	12 (27.3%)	
Methicillin-resistant S. aureus	2 (1.8)	2 (2.9%)	0 (0.0%)	
Coagulase-negative staphylococci	8 (7.1)	2 (2.9%)	6 (13.6%)	
Streptococcus species	20 (17.8)	12 (17.6%)	8 (18.2%)	
Enterococcus species	2 (1.8)	1 (1.5%)	1 2.3%)	
Escherichia coli	3 (2.7)	1 (1.5%)	2 (4.5%)	
Polymicrobial	7 (6.3)	5 (7.4%)	2 (4.5%)	
Other gram-positive organisms	1 (0.9)	1 (1.5%)	0 (0.0%)	
Other gram-negative organisms	2 (1.8)	1 (1.5%)	1 (2.3%)	
Culture-negative	37 (33.0)	25 36.8%)	12 (27.3%)	

mortality during the total PJI care for patients treated by FT was also observed.

The interest in comparative studies assessing clinical outcomes between surgeons with relevant fellowship training and surgeons without fellowship training has grown across the orthopaedic literature. The results of this study highlight that surgeries performed by surgeons with fellowship training in arthroplasty significantly improve the odds of treatment success, which is perhaps a reflection of differences in both PJI case experience, surgical technique (ie, quality and extent of debridement), knowledge of current best-practices, and comfort with alternative and potentially beneficial treatment strategies. Similarly, Mabry et al. investigated the outcomes of hemiarthroplasty for femoral neck fractures based on surgeon fellowship training [35]. They found that fellowship training was associated with shorter operative times and fewer complications compared to general orthopaedic surgeons. Singh et al. recently compared outcome differences between primary TKA performed by fellowship-trained arthroplasty surgeons and nonfellowship-trained surgeons [36]. The authors demonstrated that TKAs performed by fellowship-trained arthroplasty surgeons correlated with significantly shorter surgical times and greater improvements in patient-reported outcome measures, including the Knee Injury and Osteoarthritis Outcome Score for Joint Replacement, and the Veterans RAND-12 Physical and Mental Components scores. Mahure *et al.* also conducted a large retrospective review of perioperative metrics for primary total hip arthroplasty and TKA's performed by FT vs NoFT surgeons. They found that FT surgeons had shorter operative times and hospital stays for both total hip arthroplasty and TKA's. They also found higher Activity Measures Post-Acute Care scores in the FT TKA patients indicating higher metrics in postoperative mobilization [21]. As such, despite a growing interest in evaluating differences in outcomes related to surgical training, such studies are lacking in the field of musculoskeletal infections. The results of the current study support the findings of other studies in the field of orthopaedic surgery, highlighting the benefit of fellowship training in patient care.

The results of this study show no difference in mortality for patients treated by nonarthroplasty-trained surgeons. Toh et al. recently showed that DAIR failure was associated with earlier time to mortality compared to patients whose infections were eradicated with DAIR [37]. Rajgopal *et al.* found an increase in the requirement of soft-tissue defect coverage using muscle flaps, and postoperative stiffness was noted in patients who had failed DAIR [13,38-40]. As such, the results of our study and those of others highlight the importance of optimizing initial PJI management—"getting it right the first time."

At a mean follow-up of 7.3 years, 59.8% of patients in this study failed initial DAIR treatment despite all surgeries being performed open with modular component exchange—2 technical aspects known to influence the treatment success of DAIR [41,42]. Such a high failure rate may be a result of the indication for which DAIR was performed, as the majority of DAIRs in this study were performed for acute hematogenous PJI. A recent systematic review performed by Balato et al. found a higher treatment failure rate when DAIR was performed for acute hematogenous infections vs those performed for early-onset infections [14,43]. The proportion

Table 3
Treatment outcomes.

Treatment outcomes	Total	FT	NoFT	*P*-value
	N = 112	N = 68	N = 44	
Treatment failure	67 (59.8%)	33 (48.5%)	34 (77.3%)	.0024
Suppressive antibiotics	32 (28.6%)	16 (23.5%)	16 (36.4%)	.437
Reoperation	42 (37.5%)	22 (32.3%)	20 (45.5%)	.162
Death	24 (21.4%)	11 (16.2%)	13 (29.5%)	.092
Soft tissue reconstruction	6 (5.35%)	5 (7.35%)	1 (2.27%)	.244
Amputation	3 (2.68%)	2 (2.97%)	1 (2.27%)	.831

Table 4
Treatment outcomes based on the ICM's treatment success classification.

ICM treatment classification	Total	FT	NoFT	*P*-value
	N = 112	N = 68	N = 44	
Tier 1	45 (40.2%)	35 (51.5%)	10 (22.7%)	.0024
Tier 2	23 (20.5%)	10 (14.7%)	13 (29.5%)	.057
Tier 3	42 (37.5%)	22 (32.4%)	20 (45.4%)	.162
Tier 4 (A)	2 (1.78%)	1 (1.47%)	1 (2.27%)	.754

Tier 1: infection control with no continued antibiotic therapy; Tier 2: infection control with suppressive antibiotic therapy; Tier 3: need for reoperation; Tier 4 (A): death <1 year from the initiation of PJI treatment.

Table 5
Treatment outcomes based on year.

Years	Total	FT	NoFT	*P*-value
	N = 112	N = 68	N = 44	
1996-2012				
Number of DAIRs	N = 37	N = 21	N = 16	.071
Number of failures	26 (70.3%)	12 (57.1%)	14 (87.5%)	
2013-2018				
Number of DAIRs	N = 75	N = 47	N = 28	.024
Number of failures	41 (54.6%)	21 (44.7%)	20 (71.4%)	

of culture-negative PJIs noted in both groups was 36.8% and 27.3% for the FT and NoFT cohorts, respectively. Both of these values are in line with current reports of culture negativity within the PJI literature with reports ranging from 5%-42% [44]. Only 33% of the DAIRs were performed prior to the 2013 MSIS consensus meeting definition of PJI with 67% occurring afterward [8]. This timeframe was selected in order to identify if this landmark PJI publication played a factor in DAIR failure rates. We do acknowledge the risk of time-interval bias. There was no difference between failure rates prior to 2013, with a significant failure rate in the NoFT group following 2013 ($P = .02$). Despite all DAIRs being completed within the accepted timeframes, this would suggest that surgeons who have fellowship training are more closely adhering to the recommended guidelines, as they are not limited to solely providing DAIR but more extensive revisions if required. There was also a total of 16 NoFT surgeons that performed DAIRs between 2013 and 2018. This would equate to 1.75 DAIRs performed per NoFT surgeon over that time period, in comparison to 6.71 DAIRs per the 7 FT surgeons in the same timeframe. This would suggest that many NoFT surgeons were not performing a yearly DAIR, while the FT surgeons were averaging at least 1 DAIR per year. This breakdown shows that the difference in volumes could be another factor affecting success rates between cohorts. Our study focuses on the Tier 1 definition from the 2018 ICM consensus meeting on treatment success. This includes infection control without the need for chronic suppressive antimicrobial therapy. There are some circumstances where the Tier 2 definition is acceptable (infection control with chronic suppressive antimicrobial therapy). In our study, our cohorts included patients who underwent DAIR in the context of a first-time primary TKA PJI, where a more stringent Tier 1 definition applies. Although our study does not find independent statistical differences between

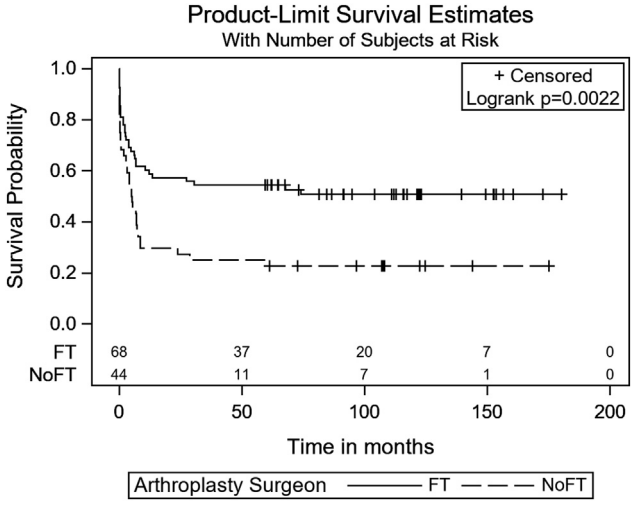

Figure 1. DAIR survivorship.

reoperation rate, the use of chronic suppressive antimicrobial therapy, or death as related to PJI between the cohorts. When they are summed as defined by the Tier 1 definition, we do find statistical differences between the cohorts.

This study has several limitations. Notably, it is a retrospective review of retrospectively collected data with relatively small numbers and suffers from all associated biases, including potential selection bias. Both cohorts underwent DAIRs in similar circumstances in terms of time between index procedure and DAIR. Although a crude measurement of infection severity, there were no differences between ESR and CRP between the cohorts. DAIRs were performed as added procedures at the end of both NoFT and FT surgeons' elective procedures, along with being completed as on-call procedures in both cohorts. Despite this, there is still a risk of selection bias between cohorts. The division of pre-2013 and post-2013 DAIRs was done to analyze if the publication of the MSIS diagnostic criteria could have played a factor in DAIR failure rates. We acknowledge that this could introduce an element of time interval bias. However, given the low incidence of TKA PJI, retrospective observational studies serve as the best evidence currently available. Moreover, we acknowledge the limitations of using fellowship training as a surrogate for both experience and evidence-based treatment of PJI in TKA. We would, however, suggest that subspecialty fellowship training generally correlates with knowledge of current guidelines and case volumes/experience at many centers, as is the case at our institution [21,22]. Another limitation of this study is the time-based categorization of PJIs. We acknowledge the general move away from traditional time-based divisions of acute and chronic infections with more recent emphasis on PJI as a continuum that leads to the establishment of biofilm [7,45]. However, such cut-offs are commonly used at many centers and represent an objective means to characterize infections [7,45]. Furthermore, we acknowledge the challenge posed by the collection of the exact timing of SO for acute hematogenous infections, which may have affected our results. This was most notable for patients transferred from outside centers but did not affect our categorization based on the current definitions. Moreover, even with the knowledge of the exact timing of SO, this is a patient-reported metric. As such, we acknowledge the possibility that an acute hematogenous infection may be misclassified and could represent the exacerbation of a chronic infection [42]. Moreover, as the decision to perform DAIR was left at the discretion of the treating surgeon based on the individual's knowledge and assessment of the clinical picture, there is the potential for selection bias. We would argue, however, that such a pragmatic approach highlights real-world outcomes affected by both knowledge of treatment strategies and experience. The selection of DAIR candidates likely changed over time with the evolution of PJI treatment. Due to the retrospective nature of our study, it was not possible to capture these selection factors. Lastly, after the end date of this study, our center established a multidisciplinary team (MDT) PJI service. This is led by 4 arthroplasty surgeons with an interest in PJI and was adopted as there is growing consensus that patients with PJI should be treated at specialized centers with a dedicated MDT PJI service [10,46]. We would argue, however, that most centers do not possess such specialized services. Therefore, the results of this study, which predate MDT implementation, are more applicable to the current practice in most centers.

Conclusions

Our study suggests that periprosthetic knee infections initially treated with DAIR have improved treatment success without the need for chronic suppressive antimicrobial therapy if surgery is performed by fellowship-trained arthroplasty surgeons. As such,

DAIR should not be viewed as a "simple" procedure. Knowledge of evidence-based indications and contraindications for DAIR, enhanced surgical technique, and comfort level with potentially more appropriate treatment alternatives may explain differences in treatment success for DAIR in TKA according to arthroplasty fellowship training and experience. In centers without a dedicated PJI service, we recommend streamlining the care of these patients to surgeons with arthroplasty fellowship training and experience in an effort to achieve successful PJI treatment at the first encounter.

Conflicts of interest

G. Grammatopoulos is a DePuy speaker and receives research support from CIHR, Stryker, Zimmer Biomet, FormusLabs, and the Arthritis Society. S. Garceau receives research support from Smith & Nephew and Next Science LLC. All other authors declare no potential conflicts of interest.

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CRediT authorship contribution statement

Nicholas Tubin: Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Jonathan Brouget-Murray:** Writing – review & editing, Data curation. **Antoine Bureau:** Data curation. **Jared Morris:** Conceptualization. **Marsa Azad:** Writing – review & editing. **Hesham Abdelbary:** Writing – review & editing. **George Grammatopoulos:** Writing – review & editing. **Simon Garceau:** Writing – review & editing, Supervision, Formal analysis.

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