Original Article

Postoperative Anterior Cruciate Ligament Reconstruction Quadricep and Patella Tendon Rupture, Infection, and Lysis of Adhesions Decreased Despite Changing Graft Trends Over the Past Decade

Hayden P. Baker, M.D., Sarah Bhattacharjee, M.D., Charles Poff, M.D., Collin Bartolotta, B.S., and Aravind Athiviraham, M.D.

Purpose: To investigate recent trends in postoperative complications following anterior cruciate ligament (ACL) reconstruction. **Methods:** Patients who underwent ACL reconstruction surgery were identified in a national insurance database and separated into 2 cohorts based on the date of their initial surgery comprising the years 2010 to 2012 and 2016 to 2018, respectively. Patients were matched 1:1 based on comorbidities and Elixhauser Comorbidity Index. All patients were assessed for postoperative complications within 18 months of surgery. Rate of complication was compared between cohorts. **Results:** Overall, the all-cause complication rate was 2%. There were significantly more quadriceps tendon rupture, patella tendon rupture, lysis of adhesion, and infection in the early cohort. There were significantly more instances of deep vein thrombosis in the late cohort. We found no significant difference in manipulations under anesthesia between the 2 cohorts. **Conclusions:** Patients who underwent surgery in the late cohort had lower rates of postoperative complications, except for deep vein thrombosis. The rate of postoperative quadriceps tendon rupture decreased despite considerable increase in the use of quadriceps tendon autograft. **Clinical Relevance:** As there has been an increased use of quadriceps tendon autografts, but little is known about the postoperative complications after ACL reconstruction with these grafts. This information has the potential to improve patient outcomes.

Anterior cruciate ligament (ACL) tears are one of the most common orthopaedic injuries sustained in the United States, with an annual incidence of 68.6 per 100,000 person-years.[1] ACL reconstruction is most commonly performed using either bone—patellar tendon—bone (BPTB) or hamstring tendon (HT) autograft; however, use of quadriceps tendon (QT) autograft has increased over the past decade.[2,3] Reported advantages of QT autograft include ease of harvest, large cross-sectional area, and relatively low donor-site morbidity.[4,5] In less than 5 years, the rate of QT autograft use increased 4-fold from 2.5% in 2010 to 11% in 2014.[6] A recent survey of the ACL study group demonstrated that the popularity of QT autograft has continued to increase from 2014 to present.[7] It is also known that QT autograft is becoming increasingly used in revision ACL reconstruction, possibly due to decreased failure rates relative to HT autograft.[8] As QT use has increased since 2010, so too has its inclusion in orthopaedic literature. A systematic review by Heffron et al.[9] showed that since its introduction to orthopaedic literature in 1979, 30% of all publications on QT for ACL reconstruction were published between 2016 and 2019.

BPTB and HT are traditionally thought to be the standard choices for ACL reconstruction autograft; however, recent data have shown that outcomes for QT versus BPTB and HT are, at least, equivocal. Cavaignac et al.[10] found that Lysholm, Knee Injury and Osteoarthritis Outcome Score, and Knee Injury and Osteoarthritis Outcome Score Sport scores were significantly improved in patients grafted with QT versus HT. In the

From the Department of Orthopaedic Surgery, The University of Chicago, Chicago, (H.P.B., S.B., C.P., A.A.) and the University of Illinois, Urbana-Champaign (C.B.), Illinois, U.S.A.

The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received February 15, 2022; accepted April 27, 2022.

Address correspondence to Hayden P. Baker, M.D., 5758 S. Maryland Ave., Dept. 4B, Chicago, IL 60637. E-mail: hpbaker65@gmail.com

2666-061X/22228

https://doi.org/10.1016/j.asmr.2022.04.033

same study, indices of stability such as side-to-side difference and presence of negative Lachman test were improved in the QT group.[10] Recent systematic reviews have gone on to demonstrate no significant differences in patient-reported outcomes, stability indices, and graft failure rates in patients treated with QT compared with both BPTB and HT. In fact, QT was shown to have lower rates of anterior knee pain and donor-site pain than BPTB.[2,5]

The purpose of this study was to investigate recent trends in postoperative complications following ACL reconstruction. Our null hypothesis was that there would be no significant difference in the rate of postoperative complications between the 2 cohorts despite a significant increase in QT use for ACL reconstruction since 2010.

Methods

Database

This retrospective study was conducted using PearlDiver, a national insurance claims database widely used in orthopaedic literature. PearlDiver comprises more than 93 million individual patient records spanning 2010 to 2020. These records are searchable using physician billing codes including *International Classification of Diseases, Revisions 9* and *10* (ICD-9/ICD-10) diagnostic codes, Current Procedural Terminology (CPT) procedural codes, and drug codes.

Patient Selection

All patients who underwent an ACL reconstruction were identified in the database via CPT 29888 and sorted based on the date of their surgery into 2 cohorts: an early cohort comprising the years of 2010 to 2012 and a late cohort from 2016 to 2018. As we were interested in comparing their postoperative complications, all patients were required to be continuously active for 18 months in the database following the initial date of surgery.

We matched patient comorbidities 1:1 based on age, sex, tobacco use, obesity, diabetes, and Elixhauser Comorbidity Index between the 2 cohorts. Postoperative surgical complications included QT rupture, patellar tendon rupture, manipulation under anesthesia, return to the operating room for lysis of adhesions, infection, and deep vein thrombosis (DVT). The surgical complications rates were defined using CPT and ICD-9 codes.

Statistical Analysis

We used Pearson χ^2 analysis to assess the univariate difference in rates of surgical complications between the early and late cohorts. The Student *t*-test was used to compare continuous variables. All tests were conducted at an alpha level of 0.05. For complication outcomes that were statistically significant, a multivariate logistic regression was used to account for potential confounding from the comorbidities and demographic factors of age, sex, tobacco use, obesity, and diabetes. The adjusted odds ratios (ORs) and confidence intervals (CIs) were determined from the multivariate analysis. Statistical analysis was done using the R statistical package available through PearlDiver.

Table 1. Patient Demographics

Demographics	Early Cohort (n = 27,057)	Late Cohort (n = 27,057)	*P* Value
Obesity	5,356 (19.8%)	5,356 (19.8%)	1
Diabetes	2,163 (7.9%)	2,163 (7.9%)	1
Tobacco	5,761 (21.3%)	5,761 (21.3%)	1
>60 years old	518 (1.9%)	518 (1.9%)	1
Female	14,254 (52.7%)	14,254 (52.7%)	1

NOTE. n = 54,114. Patient demographics showing the percentage of patients with diagnosis of obesity, history of diabetes, history of tobacco use, age older than 60 years, and female sex in both the early (2010-2012) and late (2016-2018) cohorts.

Results

A total of 80,376 patients who underwent ACL reconstruction were identified, 46,024 of whom underwent surgery in the years 2010 to 2012, and 34,352 of whom underwent surgery in the years 2016 to 2018 with 18 months of follow-up. After matching patient comorbidities and Elixhauser Comorbidity Index 1:1, 27,057 patients remained in each cohort (Table 1). Overall, the all-cause complication rate was 2%. There was significantly more QT rupture, patella tendon rupture, lysis of adhesion, and infection in the early cohort (Table 2). However, there was significantly more DVTs in the late cohort. We found no significant difference in manipulations under anesthesia (MUA) between the 2 cohorts.

The univariate and multivariate logistic regression results are listed in Appendices 1 to 8, available at www.arthroscopyjournal.org. Univariate analysis demonstrated QT rupture to be independently associated with diabetes (OR 5.24; 95% CI 1.65-14.4). MUA was found to be independently associated with female sex (OR 2.3; 95% CI 1.86-2.85). Patella tendon rupture and lysis of adhesions were not found to be associated

Table 2. Complication Rates

Outcomes	Early Cohort (n = 27,057)	Late Cohort (n = 27,057)	*P* Value
Quadriceps rupture	15 (0.1%)	1 (0.003%)	**<.001**
Patella tendon rupture	12 (0.04%)	1 (0.003%)	**.003**
Manipulation	198 (0.7%)	221 (0.8%)	.178
Adhesion lysis	22 (0.08%	8 (0.03%)	**.013**
Infection	344 (1.3%)	191 (0.7%)	**<.001**
DVT	3 (0.01%)	89 (0.3%)	**<.001**

NOTE. *P* values in bold indicate statistical significance.
DVT, deep vein thrombosis.

with any patient comorbidities. Infection was found to be associated with female sex, obesity, and tobacco use on multivariate analysis, whereas DVT was found to associated with diabetes and obesity.

Discussion

The most important finding of our study was that patients who underwent ACLR in the late cohort had lower rates of postoperative complications, except for DVT. Counterintuitively, there was a significantly lower number of postoperative QT ruptures in patients who underwent ACL reconstruction in the late cohort despite increasing popularity of QT autograft over the past decade. The rate of patella tendon rupture also significantly decreased in the late cohort; however, this observation may be secondary to the decreasing popularity of BPTB autograft for ACL reconstruction over the past 2 decades (preferred graft for 90% of surgeons in 1990 to under 40% in 2021).[7,11]

There was a significant increase in the rate of DVTs in the late cohort. At our institution pharmacologic thromboprophylaxis is not routinely prescribed for patients following ACL reconstruction. A recent national insurance database study reported that only 3.5% of the more than 14,000 patients included in the study received pharmacologic thromboprophylaxis following ACL reconstruction.[12] Interestingly, pharmacologic thromboprophylaxis other than aspirin (acetylsalicylic acid) was associated with increased risk of procedural intervention for arthrofibrosis after ACL reconstruction.[12] In our study, DVT was associated with diabetes and obesity. Not using a tourniquet has also previously been reported to decrease the incidence of DVT after ACL reconstruction.[13] Surgeons should consider forgoing or limiting the use of tourniquet in patients who are high risk for postoperative DVT (those with obesity, diabetes, or those who are smokers).[14,15]

The overall infection rate was low between the 2 cohorts, approximately 1%. Infection, not surprisingly, was associated with obesity and tobacco use, which has previously been reported.[16] Baron et al.[17] previously demonstrated that ACL graft preparation with vancomycin-soaked grafts were associated with a 10-fold reduction in infection rate after ACL reconstruction (0.1 vs 1.2%). Graft preparation with vancomycin-soaked gauze for high-risk patients (those with obesity or those who are smokers) should be considered.

The rate of return to the operating room for postoperative lysis of adhesion was found to be significantly lower in the late cohort. These findings may be secondary to the continued emphasis on the importance of prehabilitation before ACL reconstruction.[18-20] Female sex was found to be associated with MUA; this risk factor has been previously described with similar ORs to our results.[21] Interestingly there was no difference in MUA between the cohorts, despite the significant difference in lysis of adhesions.

Given the increasing popularity of QT autograft for ACL reconstruction, several studies have been published recently comparing the outcomes of QT autograft with BPTB and NT autografts. Two recently published systematic reviews demonstrated QT autograft has comparable clinical and functional outcomes and graft survival rate with BPTB and HT autografts.[2,5] Several studies have demonstrated significantly less harvest-site pain in patients who underwent ACL reconstruction with QT autograft compared with BPTB autograft.[22-26] However, three studies demonstrated no significant difference in donor-site pain when comparing HT autograft to QT autograft.[10,27,28]

Biomechanically QT autograft has properties similar to those of the native ACL.[29,30] The cross-sectional area and load to failure of the native ACL is 44 mm^2 and 1725 to 2160 N, respectively.[31] While the tensile strength of the QT autograft is 2352 N, which exceeds the load to failure of the native ACL, and is similar to the tensile strength of BPTB(2977 N) and quadriceps autograft (2422 to 4090 N).[31] However, in comparison, the cross-sectional area of QT autograft is larger (62 mm^2) than HT (53 mm^2) and BPTB (35 mm^2) autografts.[31,32] Thus, QT autograft provides a thicker graft, compared with HT and BPTB autograft, with acceptable load to failure strength and similar clinical and functional outcomes.

Both QT and BPTB autograft are harvested from the extensor mechanism; thus, potential donor-site morbidity theoretically is similar between the 2 graft choices. However, BPTB carries a greater incidence of morbidity in terms of anterior knee pain, patella fracture, patella tendon rupture, patellofemoral arthritis, kneeling pain, and infrapatellar nerve injury.[30,33-37] In their series of 5364 ACL reconstructions with BPTB autograft, Benner at al.[33] reported an incidence of patella tendon rupture of 0.24%. In comparison with our findings, the rate of patella tendon rupture after ACL reconstruction with BPTB autograft reported by Benner et al. is approximately 1,000 times that of QT rupture following ACL reconstruction. Thus, all-soft tissue QT auto graft demonstrates a lower rate of extensor mechanism disruption when compared BPTB autograft.

Limitations

This paper has a number of limitations consistent with those of any database study. The power of this paper rests on the validity of physician billing and coding, which at times can be imprecise. Although previous studies have reported the error rate of coding to be roughly 1.3%, it is important nonetheless to acknowledge that we are unable to report the accuracy of the coding in this dataset. Unfortunately, there is only one CPT code for ACL reconstruction (29888), and it does

not further specify between ACL repair, ACL reconstruction, and if reconstruction was performed whether autograft or allograft was used and the technique performed. Further, the PearlDiver database does not code for laterality, thus we were unable to confirm whether the 20 cases of QT rupture were on the ipsilateral side of the ACL reconstruction. Thus, it is likely that our findings overestimated the number of QT ruptures following ACL reconstructions, and our findings should be interpreted with this in mind.

Conclusions

Patients who underwent surgery in the late cohort had lower rates of postoperative complications, except for DVT. The rate of postoperative QT rupture decreased despite considerable increase in the use of QT autograft.

References

1. Sanders TL, Maradit Kremers H, Bryan AJ, et al. Incidence of anterior cruciate ligament tears and reconstruction: A 21-year population-based study. *Am J Sports Med* 2016;44:1502-1507.
2. Hurley ET, Calvo-Gurry M, Withers D, Farrington SK, Moran R, Moran CJ. Quadriceps tendon autograft in anterior cruciate ligament reconstruction: A systematic review. *Arthroscopy* 2018;34:1690-1698.
3. Middleton KK, Hamilton T, Irrgang JJ, Karlsson J, Harner CD, Fu FH. Anatomic anterior cruciate ligament (ACL) reconstruction: A global perspective. Part 1. *Knee Surg Sports Traumatol Arthrosc* 2014;22:1467-1482.
4. Lavender C, Fravel W, Patel T, Singh V. Minimally invasive quad harvest featuring endoscopic closure and preparation with adjustable suspensory fixation device incorporated with braided suture. *Arthrosc Tech* 2021;10:e217-e220.
5. Mouarbes D, Menetrey J, Marot V, Courtot L, Berard E, Cavaignac E. Anterior cruciate ligament reconstruction: A systematic review and meta-analysis of outcomes for quadriceps tendon autograft versus bone-patellar tendon-bone and hamstring-tendon autografts. *Am J Sports Med* 2019;47:3531-3540.
6. Widner M, Dunleavy M, Lynch S. Outcomes following ACL reconstruction based on graft type: Are all grafts equivalent? *Curr Rev Musculoskelet Med* 2019;12:460-465.
7. Arnold MP, Calcei JG, Vogel N, et al. ACL Study Group survey reveals the evolution of anterior cruciate ligament reconstruction graft choice over the past three decades. *Knee Surg Sports Traumatol Arthrosc* 2021;29:3871-3876.
8. Winkler PW, Vivacqua T, Thomassen S, et al. Quadriceps tendon autograft is becoming increasingly popular in revision ACL reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2022;30:149-160.
9. Heffron WM, Hunnicutt JL, Xerogeanes JW, Woolf SK, Slone HS. Systematic review of publications regarding quadriceps tendon autograft use in anterior cruciate ligament reconstruction. *Arthrosc Sports Med Rehabil* 2019;1:e93-e99.
10. Cavaignac E, Coulin B, Tscholl P, Nik Mohd Fatmy N, Duthon V, Menetrey J. Is quadriceps tendon autograft a better choice than hamstring autograft for anterior cruciate ligament reconstruction? A comparative study with a mean follow-up of 3.6 years. *Am J Sports Med* 2017;45:1326-1332.
11. Yucens M, Aydemir AN. Trends in anterior cruciate ligament reconstruction in the last decade: A web-based analysis. *J Knee Surg* 2019;32:519-524.
12. Qin C, Qin MM, Baker H, Shi LL, Strelzow J, Athiviraham A. Pharmacologic thromboprophylaxis other than aspirin is associated with increased risk for procedural intervention for arthrofibrosis after anterior cruciate ligament reconstruction. *Arthroscopy* 2021;37:619-623.
13. Nagashima M, Takeshima K, Origuchi N, et al. Not using a tourniquet may reduce the incidence of asymptomatic deep venous thrombosis after ACL reconstruction: An observational study. *Orthop J Sports Med* 2021;9:232596712110566.
14. Forlenza EM, Parvaresh KC, Cohn MR, et al. Incidence and risk factors for symptomatic venous thromboembolism following anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2022;30:1552-1559.
15. Gaskill T, Pullen M, Bryant B, Sicignano N, Evans AM, DeMaio M. The prevalence of symptomatic deep venous thrombosis and pulmonary embolism after anterior cruciate ligament reconstruction. *Am J Sports Med* 2015;43:2714-2719.
16. Novikov DA, Swensen SJ, Buza JA 3rd, Gidumal RH, Strauss EJ. The effect of smoking on ACL reconstruction: A systematic review. *Phys Sportsmed* 2016;44:335-341.
17. Baron JE, Shamrock AG, Cates WT, et al. Graft preparation with intraoperative vancomycin decreases infection after ACL reconstruction: A review of 1,640 cases. *J Bone Joint Surg Am* 2019;101:2187-2193.
18. Carter HM, Littlewood C, Webster KE, Smith BE. The effectiveness of preoperative rehabilitation programmes on postoperative outcomes following anterior cruciate ligament (ACL) reconstruction: a systematic review. *BMC Musculoskelet Disord* 2020;21:647.
19. Cunha J, Solomon DJ. ACL prehabilitation improves postoperative strength and motion and return to sport in athletes. *Arthrosc Sports Med Rehabil* 2022;4:e65-e69.
20. Giesche F, Niederer D, Banzer W, Vogt L. Evidence for the effects of prehabilitation before ACL-reconstruction on return to sport-related and self-reported knee function: A systematic review. *PLoS One* 2020;15:e0240192.
21. Sanders TL, Kremers HM, Bryan AJ, Kremers WK, Stuart MJ, Krych AJ. Procedural intervention for arthrofibrosis after ACL reconstruction: Trends over two decades. *Knee Surg Sports Traumatol Arthrosc* 2017;25:532-537.
22. Geib TM, Shelton WR, Phelps RA, Clark L. Anterior cruciate ligament reconstruction using quadriceps tendon autograft: Intermediate-term outcome. *Arthroscopy* 2009;25:1408-1414.
23. Gorschewsky O, Stapf R, Geiser L, Geitner U, Neumann W. Clinical comparison of fixation methods for patellar bone quadriceps tendon autografts in anterior cruciate ligament reconstruction: Absorbable cross-pins versus absorbable screws. *Am J Sports Med* 2007;35:2118-2125.

24. Han HS, Seong SC, Lee S, Lee MC. Anterior cruciate ligament reconstruction: Quadriceps versus patellar autograft. *Clin Orthop Relat Res* 2008;466:198-204.
25. Kim SJ, Jo SB, Kumar P, Oh KS. Comparison of single- and double-bundle anterior cruciate ligament reconstruction using quadriceps tendon-bone autografts. *Arthroscopy* 2009;25:70-77.
26. Kim SJ, Kumar P, Oh KS. Anterior cruciate ligament reconstruction: Autogenous quadriceps tendon-bone compared with bone-patellar tendon-bone grafts at 2-year follow-up. *Arthroscopy* 2009;25:137-144.
27. Haner M, Bierke S, Petersen W. Anterior cruciate ligament revision surgery: Ipsilateral quadriceps versus contralateral semitendinosus-gracilis autografts. *Arthroscopy* 2016;32:2308-2317.
28. Runer A, Wierer G, Herbst E, et al. There is no difference between quadriceps- and hamstring tendon autografts in primary anterior cruciate ligament reconstruction: A 2-year patient-reported outcome study. *Knee Surg Sports Traumatol Arthrosc* 2018;26:605-614.
29. Duquin TR, Wind WM, Fineberg MS, Smolinski RJ, Buyea CM. Current trends in anterior cruciate ligament reconstruction. *J Knee Surg* 2009;22:7-12.
30. Mohtadi NG, Chan DS, Dainty KN, Whelan DB. Patellar tendon versus hamstring tendon autograft for anterior cruciate ligament rupture in adults. *Cochrane Database Syst Rev* 2011:CD005960.
31. Noyes FR, Butler DL, Grood ES, Zernicke RF, Hefzy MS. Biomechanical analysis of human ligament grafts used in knee-ligament repairs and reconstructions. *J Bone Joint Surg Am* 1984;66:344-352.
32. Harris NL, Smith DA, Lamoreaux L, Purnell M. Central quadriceps tendon for anterior cruciate ligament reconstruction. Part I: Morphometric and biomechanical evaluation. *Am J Sports Med* 1997;25:23-28.
33. Benner RW, Shelbourne KD, Urch SE, Lazarus D. Tear patterns, surgical repair, and clinical outcomes of patellar tendon ruptures after anterior cruciate ligament reconstruction with a bone—patellar tendon—bone autograft. *Am J Sports Med* 2012;40:1834-1841.
34. Ejerhed L, Kartus J, Sernert N, Kohler K, Karlsson J. Patellar tendon or semitendinosus tendon autografts for anterior cruciate ligament reconstruction? A prospective randomized study with a two-year follow-up. *Am J Sports Med* 2003;31:19-25.
35. Ferrer GA, Miller RM, Murawski CD, et al. Quantitative analysis of the patella following the harvest of a quadriceps tendon autograft with a bone block. *Knee Surg Sports Traumatol Arthrosc* 2016;24:2899-2905.
36. Kartus J, Movin T, Karlsson J. Donor-site morbidity and anterior knee problems after anterior cruciate ligament reconstruction using autografts. *Arthroscopy* 2001;17:971-980.
37. Liden M, Ejerhed L, Sernert N, Laxdal G, Kartus J. Patellar tendon or semitendinosus tendon autografts for anterior cruciate ligament reconstruction: A prospective, randomized study with a 7-year follow-up. *Am J Sports Med* 2007;35:740-748.

Appendix Table 1. Quadriceps Rupture Univariate Analysis

Characteristic	Quadriceps Rupture OR (95% CI)	*P* Value
Late Cohort	0.07 (0.01-0.33)	**<.001**
Age >60 y	3.42 (0.45-25.99)	.234
Sex (female)	0.08 (0.01-0.64)	.477
Diabetes	5.24 (1.65-14.4)	**.002**
Obesity	1.36 (0.38-3.88)	.603
Tobacco	0.85 (0.20-2.65)	.804

NOTE. *P* values in bold indicate statistical significance.
CI, confidence interval; OR, odds ratio.

Appendix Table 2. Patella Rupture Univariate Analysis

Characteristic	Patella Rupture OR (95% CI)	*P* Value
Late cohort	0.08 (0.01-0.64)	**.017**
Age >60 y	1.76 (0.99-2.27)	.988
Sex (female)	0.40 (0.13-1.30)	.126
Diabetes	0.96 (0.12-7.38)	.968
Obesity	0.74 (0.16-3.32)	.691
Tobacco	2.31 (0.76-7.07)	.142

NOTE. *P* values in bold indicate statistical significance.
CI, confidence interval; OR, odds ratio.

Appendix Table 3. Manipulation Univariate Analysis

Characteristic	Manipulation OR (95% CI)	*P* Value
Late cohort	1.12 (0.92-1.35)	.260
Age >60 y	0.62 (0.26-1.49)	.284
Sex (female)	2.30 (1.86-2.85)	**<.001**
Diabetes	1.02 (0.70-1.42)	.927
Obesity	1.14 (0.90-1.44)	.265
Tobacco	1.19 (0.95-1.49)	.126

NOTE. *P* values in bold indicate statistical significance.
CI, confidence interval; OR, odds ratio.

Appendix Table 4. Adhesion Lysis Univariate Analysis

Characteristic	Adhesion Lysis OR (95% CI)	*P* Value
Late cohort	0.36 (0.15-0.78)	**.014**
Age >60 y	2.07 (0.34-4.38)	.981
Sex (female)	0.69 (0.33-1.41)	.308
Diabetes	2.26 (0.29-4.33)	.984
Obesity	1.23 (0.49-2.73)	.627
Tobacco	1.58 (0.69-3.36)	.248

NOTE. *P* values in bold indicate statistical significance.
CI, confidence interval; OR, odds ratio.

Appendix Table 5. Infection Univariate Analysis

Characteristic	Infection OR (95% CI)	*P* Value
Late cohort	0.55 (0.46-0.66)	**<.001**
Age >60 y	0.58 (0.23.-1.18)	.184
Sex (female)	0.66 (0.55-0.78)	**<.001**
Diabetes	1.40 (1.07-1.85)	**.015**
Obesity	1.59 (1.23-1.81)	**<.001**
Tobacco	1.66 (1.38-1.99)	**<.001**

NOTE. *P* values in bold indicate statistical significance.
CI, confidence interval; OR, odds ratio.

Appendix Table 6. Infection Multivariate Analysis

Characteristic	Infection OR (95% CI)	*P* Value
Late cohort	0.49 (0.43-0.55)	**<.001**
Sex (female)	0.63 (0.56-0.71)	**<.001**
Diabetes	1.14 (0.92-1.39)	.213
Obesity	1.34 (1.15-1.54)	**<.001**
Tobacco	1.36 (1.19-1.56)	**<.001**

NOTE. *P* values in bold indicate statistical significance.
CI, confidence interval; OR, odds ratio.

Appendix Table 7. DVT Univariate Analysis

Characteristic	DVT OR (95% CI)	*P* Value
Late cohort	29.77 (9.42-94.02)	**<.001**
Age >60 y	1.14 (0.28-4.63)	.856
Sex (female)	0.98 (0.65-1.48)	.922
Diabetes	2.43 (1.42-4.17)	**<.001**
Obesity	2.73 (1.79-4.13)	**<0.001**
Tobacco	1.46 (0.93-2.30)	.104

NOTE. *P* values in bold indicate statistical significance.
CI, confidence interval; DVT, deep vein thrombosis; OR, odds ratio.

Appendix Table 8. DVT Multivariate Analysis

Characteristic	DVT OR (95% CI)	*P* Value
Late cohort	14.05 (8.18-26.68)	**<.001**
Diabetes	1.59 (1.02-2.39)	**.031**
Obesity	2.15 (1.56-2.95)	**<.001**

NOTE. *P* values in bold indicate statistical significance.
CI, confidence interval; DVT, deep vein thrombosis; OR, odds ratio.