

The Impact of Surgeon-Specific Factors on Outcomes following Anterior Cruciate Ligament Reconstruction: A Nationwide Analysis of 3,782 Surgeons

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INTRODUCTION: Following anterior cruciate ligament reconstruction (ACLR), patient-specific risk factors for clinical outcomes including reoperation and failure are well defined. However, the relationship between surgeon-specific factors and ACLR outcomes is poorly understood. The purpose of this study was to characterize the population of surgeons performing ACLR in the United States and investigate the relationship between these factors (case volume, career duration, practice type) and surgical outcomes.

METHODS:

A large insurance claims database was queried for patients undergoing primary ACLR between 2015 and 2020 with minimum two-year follow up. Providers performing at least 10 ACLRs over the study period were included and National Provider Identification (NPI) numbers were recorded. Provider sex, degree type, practice setting, and career duration were obtained via the Center for Medicaid Services' National Plan and Provider Enumeration System, a public directory of all NPI records. Practice setting was classified as academic or private according to whether the registered practice location was affiliated with an ACGME accredited orthopaedic surgery residency program. Providers were stratified according to ACLR volume, career duration, and practice setting (i.e., academic or private). Reoperations, including revision ACLR, meniscus repair and meniscectomy, chondroplasty, and arthroscopy for drainage or removal of loose or foreign bodies were recorded. Additionally, hospitalizations and emergency department visits within 90-days after the initial ACLR were tracked. The relationships between surgeon-specific factors and postoperative outcomes were investigated through chi-square tests and difference in proportion hypothesis tests.

RESULTS: A total of 44,845 patients underwent ACLR by 3,782 surgeons (**Figure 1**), of whom 97% were male and 90.8% had an allopathic degree. There were no differences in rates of revision ACLR by volume, career duration, or practice setting (**Table 1-3**). Non-ACLR arthroscopic reoperations on the ipsilateral operative knee were more likely among patients treated by ACGME affiliated surgeons (5.0%, $p = 0.02$). Patients treated by low volume (9.7%, $p = 0.02$), early career (10.3%, $p < 0.0001$), and academic practicing (9.3%, $n = 0.02$) surgeons were more likely to have ED visits within 90 days. Patients treated by early career (0.9%, $p = 0.02$) and academic practicing (0.87%, $p < 0.0001$) surgeons were more likely to have 90-day hospital readmissions.

DISCUSSION AND CONCLUSION: Low-volume, early-career surgeons practicing in an academic setting demonstrate increased risk for 90-day ED visits following initial ACLR. Case volume, career duration, and practice setting did not affect rates of revision ACLR in patients but surgeons practicing in an academic setting had greater risk for non-ACLR reoperation on the affected knee within 2 years.

Figure 1. Surgeon Demographics. Pie charts display surgeon (A) gender identity and (B) medical school training as percentage of total surgeon population.

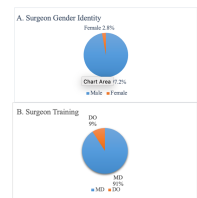


Table 1. Distribution of Surgeons by Surgeon Volume. Patient outcomes for low, medium, and high-volume surgeon cohorts were compared with chi-squared tests.

| Definition | Low Volume < 16 | Medium Volume 17-28 | High Volume > 29 | P Value |
|--|--------------------|------------------------|---------------------|-------------|
| Number of Surgeons (%) | 1261 | 1261 | 1360 | |
| Number of Patients (%) | 6190 | 9856 | 29223 | |
| Mean Case Volume | 13.01 | 20.969 | 55.611 | |
| Patient Age | 34.38 (± 12.33) | 34.57 (± 12.48) | 34.57 (± 12.38) | 0.14 |
| Patient Sex, % Female | 3264 (52.7%) | 5074 (51.2%) | 14857 (50.8%) | 0.02 |
| Non-ACLR Arthroscopic reoperation within 2 years | 254 (4.1%) | 445 (4.5%) | 1380 (4.7%) | 0.098 |
| Revision ACL Reconstruction within 2 years | 181 (2.9%) | 283 (2.9%) | 810 (2.8%) | 0.75 |
| 90-day ED Visit | 602 (9.7%) | 869 (8.8%) | 2520 (8.6%) | 0.02 |
| 90-day Hospital Readmission | 33 (0.53%) | 66 (0.67%) | 221 (0.76%) | 0.14 |

Table 2. Patient Distribution by Career Duration. Patient outcomes for early and late career surgeons compared using a difference in proportion hypothesis tests.

| Definition | Early Career NPI after 2007-06-23 | Late Career NPI prior to 2007-06-23 | P Value |
|--|--------------------------------------|--|-------------------|
| Number of Surgeons (%) | 508 | 3,274 | |
| Number of Patients (%) | 9188 | 35,888 | |
| Mean Case Volume | 25.6 | 30.6 | |
| Patient Age | 33.35 (± 11.87) | 34.84 (± 12.66) | <0.0001 |
| Patient Sex, % Female | 4,652 (50.6%) | 18,436 (51.2%) | 0.3 |
| Non-ACLR Arthroscopic reoperation within 2 years | 421 (4.6%) | 1646 (4.6%) | 1 |
| Revision ACL Reconstruction within 2 years | 255 (2.8%) | 1,006 (2.8%) | 1 |
| 90-day ED Visit | 945 (10.3%) | 3027 (8.4%) | <0.0001 |
| 90-day Hospital Readmission | 81 (0.9%) | 235 (0.65%) | 0.02 |

Table 3. Patient Distribution by ACGME Program Affiliation. Patient outcomes for surgeons practicing in setting affiliated with ACGME accredited orthopaedic residency program compared with surgeons practicing in the community setting using difference in proportion hypothesis tests.

| Definition | ACGME Program | No ACGME Program | P Value |
|--|-----------------|------------------|-------------------|
| Number of Surgeons (%) | 544 | 3,238 | |
| Number of Patients (%) | 12200 | 32792 | |
| Mean Case Volume | 46.6 | 27.0 | |
| Patient Age | 33.79 (± 12.14) | 34.82 (± 12.65) | <0.0001 |
| Patient Sex, % Female | 6083 (50.6%) | 16982 (51.8%) | 0.0003 |
| Non-ACLR Arthroscopic reoperation within 2 years | 605 (5%) | 1458 (4.4%) | 0.02 |
| Revision ACL Reconstruction within 2 years | 341 (2.8%) | 920 (2.8%) | 1 |
| 90-day ED Visit | 1136 (9.3%) | 2827 (8.6%) | 0.02 |
| 90-day Hospital Readmission | 106 (0.87%) | 102 (0.31%) | <0.0001 |