Trends and Complications of Medial Patellofemoral Ligament Reconstruction Among Applicants for the American Board of Orthopaedic Surgery Part II and Maintenance of Certification Examinations

Analysis of Data Over a 15-Year Period

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Background: Medial patellofemoral ligament reconstruction (MPFLR) and tibial tubercle osteotomy (TTO) are commonly performed surgical procedures that often have a high learning curve.

Purpose: To review the American Board of Orthopaedic Surgery (ABOS) Part II oral examination case list and the Maintenance of Certification (MOC) examination case list databases for trends in MPFLR (isolated and with concurrent TTO) and complication rates.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: We reviewed the ABOS Part II and MOC case list databases for diagnosis codes relating to patellar instability and Current Procedural Terminology codes specific to MPFLR and TTO regarding cases submitted by applicants for these examinations between 2003 and 2017 (for ABOS Part II) and between 2010 and 2017 (for MOC). Data were analyzed using generalized estimating equations with a binomial distribution and logit link to determine how trends in MPFLR changed over the study period in these applicant groups (ABOS vs MOC) as well as any influence on complication rates.

Results: In the ABOS group, the number of MPFLRs performed by surgeons increased a mean 3% each year, ranging from 66 in 2003 to 184 in 2015 (injury rate ratio, 1.03; 95% CI, 1.02-1.04; $P < .001$). In the MOC group, the mean number of MPFLRs did not change significantly (range, 119 in 2011 vs 230 in 2013; $P = .772$). In the ABOS group, after adjusting for patient age and examination year, MPFLR combined with TTO was associated with 92% greater odds of having a complication versus isolated MPFLR (odds ratio, 1.92; 95% CI, 1.24-2.98; $P = .004$), whereas the MOC group demonstrated no significant difference in the odds of having a complication between cases with versus without a concurrent TTO ($P = .214$).

Conclusion: In the current study, the number of MPFLRs performed by the less experienced surgeons in the ABOS group increased a mean 3% each year, whereas this number remained stable for the more experienced MOC group. Additionally, there were significantly more complications with MPFLR and concomitant TTO among the ABOS Part II candidates compared with the MOC candidates. These findings may be helpful in surgical decision making and education in patellofemoral instability.

Keywords: patellar instability; MPFLR; tibial tubercle osteotomy; patellofemoral

Patellar stability is provided by bony and soft tissue structures, and the interplay of these structures in dynamic movements of the knee, along with abnormalities in any

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of these structures, can cause the patella to subluxate or dislocate laterally. Patellar instability most commonly affects adolescents between 10 and 17 years of age, with a reported dislocation rate of between 29% and 43%.[4,14,23] The overall incidence of acute patellar dislocation is 5.8 per 100,000 people in the United States.[3,14,23] Upon a lateral dislocation, the medial soft tissues undergo trauma, leading many surgeons to state that disruption of the medial patellofemoral ligament (MPFL) is the "essential lesion" required for patellar dislocation.[4,9,14,20,23]

The MPFL has been shown to be the main static soft tissue restraint to lateral translation of the patella.[8,9] Continued research in the structure has led to evolving theories of the insertion on the patella and extensor mechanism. In 2013, Fulkerson and Edgar[15] proposed the attachment of the MPFL to be on the quadriceps tendon and coined the term "medial quadriceps tendon–femoral ligament." In 2019, members of the Patella Study Group recommended a broader term, the "medial patellofemoral complex," acknowledging that the proximal fibers of the MPFL do attach to the quadriceps tendon.[30]

Recent advances in orthopaedic surgery, combined with this increased knowledge of anatomy and pathology of the medial side of the knee, has led to increased interest in treating patellofemoral instability with MPFL reconstruction (MPFLR).[18,30] MPFLR for patellar instability assists in restoring stability.[2,21,22] Additional patellar stabilization procedures such as vastus medialis obliquus advancement, lateral retinacular release/lengthening, trochleoplasty, and tibial tubercle osteotomy (TTO) can be performed concomitantly with MPFLR as indicated. Several studies have reported favorable outcomes after isolated MPFLR, including decreased unstable events and improved function.[12,13,25] However, multiple pathoanatomic risk factors exist for patellar instability, including patella alta, trochlear dysplasia, limb malalignment, and malrotation, as well as tight lateral retinaculum. Lack of complete understanding of the pathoanatomy and subsequent undercorrection of all pathoanatomic risk factors can lead to poor outcomes in isolated MPFLR.[5,6,7,24,26,29,31,32] In a recent meta-analysis of MPFLR, Shah et al[27] reported a 26.1% complication rate, with improper tunnel placement and nonanatomic tensioning largely contributing to complications.

Because patellofemoral instability is a complex dynamic of multiple risk factors and anatomic reconstruction is crucial, there is often a high learning curve. The applicants for the American Board of Orthopaedic Surgery (ABOS) Part II oral examination and the Maintenance of Certification (MOC) examination are inherently different in their years of practice, with ABOS Part II applicants recently completing training and MOC applicants recertifying after $\geq$10 years of practice experience. The purpose of this study was to review the ABOS Part II and MOC case list databases to evaluate national trends in isolated MPFLR as well as MPFLR with concomitant TTO and complication rates between these groups of surgeons. We hypothesized that the incidence of MPFLR had increased, without an accompanying increase in the incidence of patellofemoral instability.

METHODS

ABOS Part II and MOC Case List Databases

The ABOS certifies newly trained orthopaedic surgeons for Diplomate status through an application process consisting of Part I (a written examination) and Part II (oral examination). After completion of an accredited orthopaedic residency, candidates take Part I and then have to actively practice orthopaedic surgery for 22 months in good standing to be eligible for Part II. In Part II, applicants provide self-reported information of cases over a 6-month period. The information that is submitted is deidentified to allow for ABOS-approved research, for which each applicant signs a waiver. The data are then entered into a secure, internet-based database (Scribe). As all data remain anonymous, institutional review board committee was not needed for this study.

The strengths of the ABOS Part II database are that it contains all the cases (>80,000 per year) performed over a 6-month period by a large number of surgeons across the country (approximately 700 per year). The data submitted are verified by sampling during an examination, and the data are collected in a standard format under clear, uniform instructions. There are notable limitations of the database. No patient-reported outcomes are recorded or available; similarly, long-term outcomes are not available. Furthermore, reported surgical outcomes are physician derived and broad-based, without objective criteria;

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Ethical approval was not sought for the present study.

they are meant to apply to the full spectrum of orthopaedic procedures and to give an overall sense of the success or failure of a procedure. Additionally, the assessment period for each patient can vary from a few weeks to a few months, and all cases are included, even those lacking postoperative follow-up. Finally, any complications are reported by the physician and are unverified and therefore subject to reporting bias; they also are entered from drop-down menu lists containing medical and surgical categories. In 2004, the category of "surgical unspecified" was added to the complications list to capture the occurrence of rare adverse outcomes associated with the surgical procedure.

Similarly, the traditional MOC path requires surgeons to recertify Diplomate status every 10 years. During one of the last 3 years of all surgeons' current certification, they are required to submit a consecutive surgical case list starting from January 1 of the year until they have reached 75 cases. The candidate stops collecting cases after either 75 cases or all cases in that calendar year have been collected. The data submitted for each one of these cases are similar in nature and are processed similarly to the ABOS Part II. The inherent strengths of the database are similar to those for the ABOS Part II, with approximately 1500 candidate surgeons and over 100,000 cases annually. This, however, is trending downward, as the ABOS instituted a new longitudinal pathway for recertification in 2019. Last, the complications list was expanded for the 2013 examination year; thus, more specific complications from 2013 onward may be listed as "surgical unspecified" or as more general complications in prior years.

Data Collection

From January 1, 2018 through March 1, 2018, a retrospective review of prospectively collected data was performed in the ABOS database of Part II board examinee and MOC applicant case submissions for relevant International Classification of Diseases, 9th and 10th revisions (ICD-9 and -10), codes relating to patellar instability between 2003 and 2017 (ICD-9 codes: 718.36, 718.86, 836.3; ICD-10 codes: M22.00, M22.01, M22.02, M22.10, M22.11, M22.12, M25.361, M25.362). These data were then further stratified to select for Current Procedural Terminology (CPT) codes specific to MPFLR (27420, 27422, or 27427). The data set was then substratified based on the presence of the CPT code for a concomitant TTO (27418). From this, demographic data on both the surgeon and the patients were collected. Surgeon information included examination year and geographic location. A summary of MPFLR cases by geographic region and year stratified by surgeon experience (ABOS Part II vs MOC applicant) can be found in Appendix Table A1. Patient data that were collected included age, sex, and date of the procedure.

These data were then analyzed using descriptive statistics to determine how the surgical trends in MPFLR and incidence of complications changed over a 15-year period according to surgeon experience level (ABOS group vs MOC group) during the case collection period. The available data for the ABOS group were examination years 2003 to 2017, with surgeries taking place in the year prior to the examination year; for the MOC group, the available data were for examination years 2010 to 2017, with surgeries taking place 2 years prior to the examination year.

Statistical Analysis

Categorical variables were recorded as frequencies and percentages, and continuous variables were recorded as means with standard deviations, medians and interquartile ranges, and ranges. Our first aim was to determine whether the number of MPFLR cases performed by surgeons has changed over time. With data at a surgeon level, Poisson regression was used to model the number of MPFLR cases submitted per surgeon for a given examination year. To utilize all available years of data, analyses were initially stratified by group (ABOS and MOC). We included examination year as the independent variable of interest, exploring both linear and quadratic associations. To then compare groups, data were pooled but limited to the years 2010 to 2017.

Our second objective was to determine whether TTOs and patient age were associated with complications. For this analysis, data remained at an individual case level. We used generalized estimating equations with a binomial distribution and logit link to examine these associations. To account for clustering due to surgeon, we assumed an unstructured correlation structure. Examination year, patient age, and indicator for whether TTO was performed were included as covariates, regardless of statistical significance. Since the trajectory of complications was unknown, we explored quadratic forms of time. Again, analyses were stratified by study group.

Statistical analyses were conducted in R Version 3.5.3 (R-Core Team). Statistical significance was determined at an alpha level of $P < .05$. We did not adjust for multiple hypothesis testing.

RESULTS

ABOS Group

In the ABOS Part II database, 10,383 candidates submitted a total of 1,286,098 cases between 2003 and 2017 with a mean 692 candidates registering each year (range, 613-770 candidates). MPFLR represented 0.13% (n = 1652) of all cases in the ABOS group. In this group, the mean age of patients was 23 years (range, 5-99 years) with 57% being female.

MPFLR Cases. The number of MPFLRs performed by the ABOS group increased a mean 3% each year from 2003 to 2017 (injury rate ratio [IRR], 1.03; 95% CI, 1.02-1.04; $P < .001$). In 2003, only 66 MPFLRs were performed, with a mean 1.47 ± 0.84 cases per surgeon, while a peak of

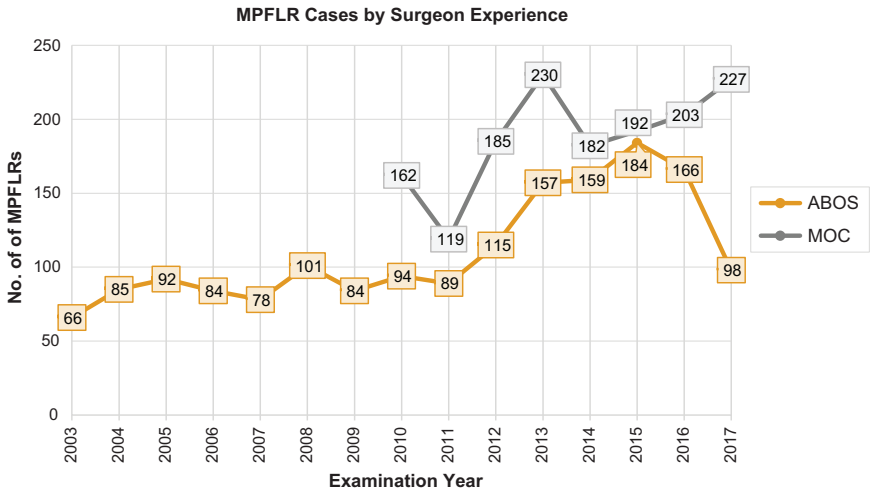

Figure 1. MPFLR cases over time by study group. ABOS, American Board of Orthopaedic Surgery; MOC, maintenance of certification; MPFLR, medial patellofemoral ligament reconstruction.

184 were performed in 2015, with a mean 2.24 ± 2.29 cases per surgeon (Figure 1).

Complications. Across the years 2003 and 2017, there were 182 complications (11%) reported in the ABOS group, with the odds of having a complication following a quadratic trend (quadratic β: 1.01; 95% CI, 1.00-1.02; P = .02; linear β: 0.81; 95% CI, 0.66-1.01; P = .06). Complication rates decreased from 13.6% (n = 66) in 2003 to 5.3% (n = 5) in 2010, then increased to 14.3% (n = 14) in 2017, with the highest rate of complication observed in 2013 (18.5%; n = 29) (Figure 2).

The 3 most common complication categories were surgical unspecified (47 cases; 25.8%), infection (30 cases; 16.5%), and wound issue (26 cases; 14.3%). A complete list of the complication categories is provided in Table 1.

From 2003 to 2017, a total of 1652 MPFLRs were performed in the ABOS group (Table 2). Of these, 156 cases (9.4%) included a concurrent TTO. Complications were reported in 30 of the 156 MPFLRs with TTO (19.2%) and in 152 of the 1496 isolated MPFLRs (10.2%) (Table 2).

After adjusting for patient age and examination year, MPFLR with TTO was associated with 92% greater odds of having a complication compared with isolated MPFLR (odds ratio [OR], 1.92; 95% CI, 1.24-2.98; P = .004). Furthermore, each 1-year increase in patient age was associated with a 2% increase in the odds of having a complication (OR, 1.02; 95% CI, 1.01-1.04; P < .001).

MOC Group

On average, 1407 candidates (range, 1168-1663) registered in the MOC database each year. A total of 831,030 cases were submitted by 11,253 candidates between the years 2010 and 2017. The 1500 MPFLRs by the MOC group represented 0.18% of these cases. The mean age of patients undergoing MPFLR in the MOC group was 25 years (range, 2-84 years), and 59% were female.

MPFLR Cases. On average, 188 MPFLR cases were performed annually during the study period by the MOC group. The number of MPFLR cases peaked at 230 cases in 2013 with a mean 1.74 ± 1.78 cases per surgeon and reached a low of 119 in 2011 with a mean 1.38 ± 0.74 cases per surgeon. There were no significant differences in MPFLR cases from 2010 to 2017 (IRR, 1.00; 95% CI, 0.98-1.03; P = .772) (Figure 1).

Complications. There were 97 (6.5%; n = 1500) reported complications in the MOC group (Table 1). Unlike the ABOS group, the odds of MOC cases resulting in a complication remained stable from 2010 to 2017 (OR, 1.08; 95% CI, 0.98-1.19; P = .125) (Figure 2B). Annual complication rates ranged from 4.9% in 2012 to 9.9% in 2016. Of the cases with listed complications (n = 97), the 3 most common were surgical unspecified (21 cases; 21.6%), wound issue (15 cases; 15.5%), and infection (14 cases; 14.4%) (Table 1).

Of the 1500 MPFLR cases performed by the MOC group, 134 cases (8.9%) had a concurrent TTO performed. Complications were reported in 12 of the 134 MPFLRs with concurrent TTO (9.0%) and in 85 of the 1366 isolated MPFLRs (6.2%) (Table 2). After adjusting for patient age and examination year, the odds of having a complication did not significantly differ between cases with and without a concurrent TTO (OR, 1.50; 95% CI, 0.79-2.83; P = .214).

Similar to the ABOS cohort, patient age was associated with having a complication. Specifically, the odds of having a complication increased 2% for each 1-year increase in age (OR, 1.02; 95% CI, 1.01-1.03; P = .04).

Comparison of ABOS and MOC Groups

The range of cases per surgeon for the ABOS group was 1.47 ± 0.84 to 2.24 ± 2.29 cases; for the MOC group the range was 1.38 ± 0.74 to 1.74 ± 1.78 cases. When comparing the complications between the MOC and ABOS groups and limiting the data to years 2010 through 2017, the rate

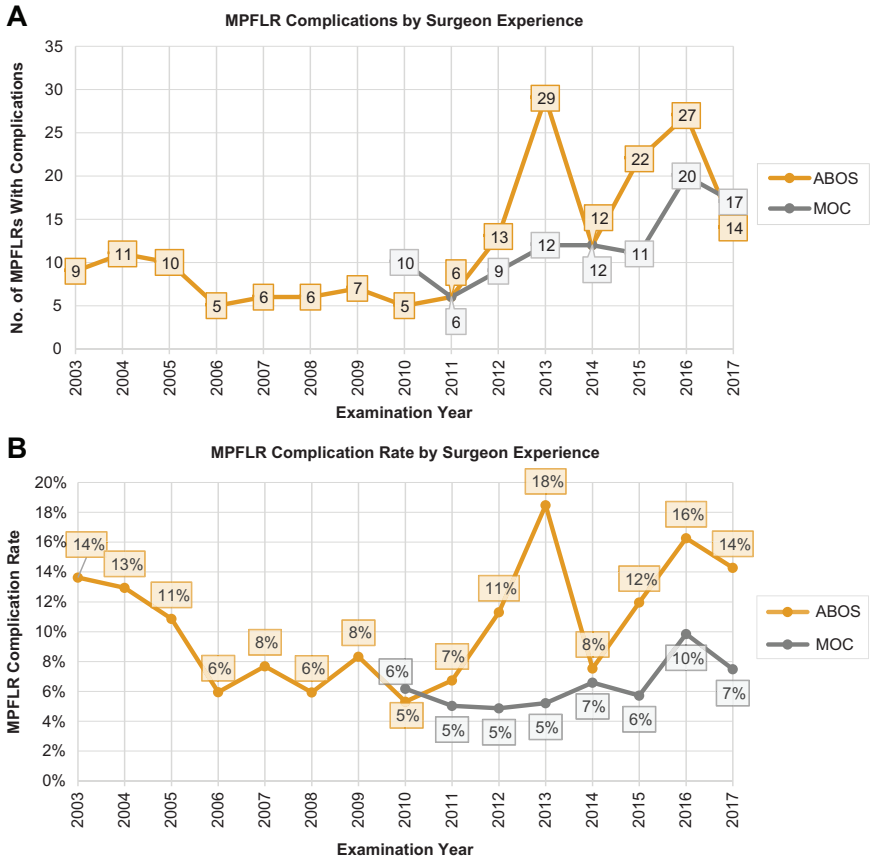

Figure 2. MPFLR complications over time by study group according to (A) number of patients and (B) complication rate. ABOS, American Board of Orthopaedic Surgery; MOC, maintenance of certification; MPFLR, medial patellofemoral ligament reconstruction.

TABLE 1
MPFLR Complications Stratified by Presence of Concurrent TTO[a]

	ABOS Group			MOC Group		
	Concurrent TTO			Concurrent TTO		
Complication	No (n = 152)	Yes (n = 30)	All (n = 182)	No (n = 85)	Yes (n = 12)	All (n = 97)
Dislocation	4 (2.6)	1 (3.3)	5 (2.7)	7 (8.2)	0 (0)	7 (7.2)
Failure of repair	8 (5.3)	3 (10.0)	11 (6.0)	8 (9.4)	1 (8.3)	9 (9.3)
Fracture	7 (4.6)	0 (0)	7 (3.8)	5 (5.9)	0 (0)	5 (5.2)
Hemarthrosis/hematoma	4 (2.6)	2 (6.7)	6 (3.3)	7 (8.2)	0 (0)	7 (7.2)
Implant failure	2 (1.3)	1 (3.3)	3 (1.6)	4 (4.7)	1 (8.3)	5 (5.2)
Infection	27 (17.8)	3 (10.0)	30 (16.5)	11 (12.9)	3 (25.0)	14 (14.4)
Nerve injury	9 (5.9)	0 (0)	9 (4.9)	0 (0)	1 (8.3)	1 (1.0)
Nonunion	2 (1.3)	0 (0)	2 (1.1)	2 (2.4)	0 (0)	2 (2.1)
Pain	10 (6.6)	2 (6.7)	12 (6.6)	4 (4.7)	0 (0)	4 (4.1)
Stiffness	17 (11.2)	7 (23.3)	24 (13.2)	3 (3.5)	3 (25.0)	6 (6.2)
Surgical unspecified	40 (26.3)	7 (23.3)	47 (25.8)	20 (23.5)	1 (8.3)	21 (21.6)
Wound issue	22 (14.5)	4 (13.3)	26 (14.3)	13 (15.3)	2 (16.7)	15 (15.5)
CRPS	0 (0)	0 (0)	0 (0)	1 (1.2)	0 (0)	1 (1.0)

[a]Data are presented as No. of cases (%). ABOS, American Board of Orthopaedic Surgery; CRPS, Complex Regional Pain Syndrome; MOC, maintenance of certification; MPFLR, medial patellofemoral ligament reconstruction; TTO, tibial tubercle osteotomy.

TABLE 2
MPFLR Complications Stratified by Presence of TTO and Patient Age[a]

	ABOS Group		MOC Group	
	Complications (n = 182)	No Complications (n = 1470)	Complications (n = 97)	No Complications (n = 1403)
No TTO[b]	152 (10.2)	1344 (89.8)	85 (6.2)	1281 (93.8)
TTO[c]	30 (19.2)	126 (80.8)	12 (9.0)	122 (91.0)
Patient age, y				
Mean ± SD	25.3 ± 13.3	22.2 ± 10.4	28.4 ± 15.7	24.3 ± 13.0
Median (IQR)	21.0 (16.0-31.0)	18.0 (15.0-26.0)	24.0 (16.0-35.0)	19.0 (16.0-29.0)
Range	6.00-99.0	5.00-82.0	8.00-77.0	2.00-84.0

[a]Data are presented as No. of cases (% for that row and group). ABOS, American Board of Orthopaedic Surgery; MOC, maintenance of certification; MPFLR, medial patellofemoral ligament reconstruction; TTO, tibial tubercle osteotomy.
[b]n = 1496 for the ABOS group, n = 1366 for the MOC group.
[c]n = 156 for the ABOS group, n = 134 for the MOC group.

of reported complications was 87% higher in the ABOS group after adjusting for examination year and number of cases performed by a surgeon within an examination year (IRR, 1.87; 95% CI, 1.44-2.44; $P < .001$; n = 1526).

DISCUSSION

Based on our data analysis, the number of MPFLRs performed by ABOS surgeons increased a mean 3% each year from 2003 to 2017 (IRR, 1.03; 95% CI, 1.02-1.04; $P < .001$). For the MOC group, the number of MPFLR cases MOC surgeons performed did not change from 2010 to 2017 (IRR, 1.00; 95% CI, 0.98-1.03; $P = .772$). In the ABOS group, after adjusting for patient age and examination year, MPFLR with TTO was associated with 92% greater odds of having a complication versus isolated MPFLR (OR, 1.92; 95% CI, 1.24-2.98; $P = .004$). In the MOC group, the odds of having a complication did not differ between MPFLR with versus without a concurrent TTO (OR, 1.50; 95% CI, 0.79-2.83; $P = .214$).

Over a 15-year period (2003-2017), there was a statistically significant upward trend in the number of MPFLR cases among the ABOS Part II candidates. To the contrary, over an 8-year period (2010-2017) there was no statistical upward or downward trend in the number of MPFLR cases among the MOC candidates. At the same time, we compared reported complication rates between the 2 groups and discovered a statistically significant higher complication rate in the ABOS group compared with the MOC group. Additionally, the ABOS group reported a significantly higher number of complications when TTO was performed concomitantly with the MPFLR, while a similar trend was not seen in the MOC group. Despite these findings, we are unable to draw conclusions due to possible differences between the groups in reporting these complications. However, in both groups a 1-year increase in patient age was found to be associated with a 2% increase in having a complication.

There is a paucity of literature reporting trends in patellofemoral stabilization surgery and specifically MPFLR. The first description of MPFLR was published in 1992 and involved passing a synthetic graft from the medial femoral condyle to the patella.[16] Since then, there has been an increased interest in MPFLR, and many evolutions in surgical techniques have been published as a result of an increased understanding of the procedure and postoperative outcomes. Stupay et al[28] performed a systematic review in 2015 of studies published between 1992 and January 2014 reporting clinical results after MPFLR. Their review included 34 studies, of which 19 were considered new contributions to the literature since October 2010, suggesting an increased interest and perhaps an increase in number of cases that were being performed.

Our data demonstrated a statistically significant upward trend of MPFLR cases in the ABOS group between 2003 and 2017. There were only 66 MPFLR cases performed in 2003 with a peak of 184 cases in 2015. Similar to these findings, a nationwide Danish registry study reported on a cohort of patients who underwent MPFLR from 1996 to 2014 and discovered a rapid rise in the use of MPFLR from 2005 to 2014.[17] Another study analyzed a large private-payer database and observed an increase in patellar instability surgeries performed from 2007 to 2014 on patients with Humana and United Healthcare insurance policies.[3] However, in our study a similar trend was not found in the MOC group, in which a mean of 188 MPFLR cases were performed annually with a peak of 230 cases in 2013 and a low of 119 cases in 2011. The reason for the difference in trends between the ABOS and MOC groups is unknown. It is possible that surgeons earlier in their careers are more likely to follow trends based on current literature and in this case developed increased awareness with continually updated MPFLR techniques that were being published. Alternatively, the discrepancy may be due to a difference in indications for surgery. It is possible that experienced surgeons have more stringent

indications before proceeding to surgical intervention due to a better understanding and exposure to the complications associated with MPFLR. Despite the overall statistically significant upward trend in number of cases within the ABOS group over the studied time period (2003-2017), there was a sudden drop-off in the number of cases performed in 2017 (98 cases) compared with 2016 (166 cases). It is unclear why this occurred. Similarly, a recent study reporting trends in ulnar collateral ligament repair of the elbow based on a national commercial database found a steady increase in cases from 2007 to 2014, followed by a decline from 2015 to 2017.[10] The authors of that study were unable to explain the drop-off.

In the current study, the overall reported complication rate was found to be 8.9% (279 of 3152 cases). Complications occurred in 182 of the 1652 cases (11%) in the ABOS group and 97 of the 1500 cases (6.4%) in the MOC group. The overall reported complication rate observed in this study (8.9%) is lower than the rate observed in a systematic review of 25 studies by Shah et al,[27] who reported a complication rate of 26.1% among patients treated with MPFLR for patellar instability. The adverse events in their study included wound complications, pain, loss of flexion, patellar fracture, dislocation, and clinical instability on examination. In addition, 26 patients underwent reoperation for additional procedures. Parikh et al[21] documented a complication rate of 16.2% (38 complications in 29 knees) after a retrospective review of 179 MPFLRs between 2005 and 2011. According to the authors, 18 of 38 (47%) complications were secondary to technical errors and were considered preventable.[21]

It is important to note that the mean follow-up time in the study by Shah et al[27] was 47 months, and Parikh et al[21] reviewed cases that were performed over a 6-year period. They reported that the mean time between surgery and presentation of the complication was 275 days, with the longest being 1095 days. However, the follow-up period in our study was variable: the collection period for the ABOS and MOC applicants was a 6-month window for when surgery occurred, followed by another 6 months when the applicants submitted their final cases and follow-up. Therefore, this shorter and variable follow-up time could have accounted for the lower overall complication rate (8.9%) we found when compared with Shah et al and Parikh et al.[21]

We discovered that a wide array of complications was reported (see Table 1). In both study groups, the largest number of complications were attributed to "surgical unspecified" with 47 out of 182 (25.8%) complications in the ABOS group and 21 out of 97 (21.6%) complications in the MOC group. It is unclear what surgeons would have considered to be a "surgical unspecified" complication. However, we suspect a large percentage of those complications involved patients with a loss of flexion who required surgical intervention to release a tight graft or other procedure such as manipulation under anesthesia to improve motion.

There was a significantly higher complication rate among the ABOS cohort (11%) compared with the MOC cohort (6.4%). When accounting for isolated MPFLR surgeries, there were 152 complications in 1496 cases (10.2%) in the ABOS group and 85 complications in 1366 cases (6.2%) in the MOC group. In patients who underwent combined MPFLR and TTO, there were 30 complications in 156 cases (19.2%) in the ABOS group and 12 complications in 134 cases (9.0%) in the MOC group. When both study groups were combined, the overall complication rate was 8.3% (237/2862) for isolated MPFLR compared with 14.5% (42/290) for MPFLR with TTO. Therefore, complication rates increased in both groups where MPFLR was combined with TTO. This finding contradicts the results of Agarwalla et al,[1] who reported no difference in adverse events at 30 days postoperatively when comparing patients who underwent isolated MPFLR, isolated TTO, and concomitant MPFLR and TTO based on the National College of Surgeons–National Surgical Quality Improvement Program database. Nonetheless, it is possible that the variability of adverse event reporting criteria could have played a role in this discrepancy. Additionally, the 30-day follow-up period in the study by Agarwalla et al was rather short and may not have captured all complications.

We discovered a significantly higher rate of complications in the ABOS group compared with the MOC group after both isolated MPFLR and MPFLR with TTO. While we were able to report this, unfortunately we cannot draw concrete conclusions. It is possible that the ABOS group was more stringent in what they considered to be a complication due to having to sit for an oral board examination after submission of their case list. In addition, the ABOS group likely had slower practices with more time to focus on each patient, resulting in a heightened awareness to subtle complications.

Limitations

There are several limitations to the current study. First, we were unable to account for associated procedures to address cartilage damage and additional soft tissue stabilizing procedures such as lateral release/lengthening and vastus medialis oblique (VMO) advancement. All these procedures have known risks and complication rates associated with them and, therefore, could have contributed to an increased complication rate in this study population if they were performed. The graft fixation methods in the literature most commonly involve suture anchors or bone tunnels, but we were unable to comment on which techniques were used in this study. According to the review and meta-analysis by Shah et al,[27] a trend of more complications was documented with the tunnel techniques compared with suture anchor techniques (29.8% and 21.6%, respectively). In another systematic review, Desai et al[11] reported patellar bone socket complication rates of 0% to 28% compared with 0% to 4%, with cortical fixation techniques and similar redislocation rates between the 2 groups. Migliorini et al[19] similarly found a decreased complication rate associated with patellar suture anchor fixation compared with bone tunnels. Owing to the 6-month collection periods for the ABOS and MOC candidates, we would anticipate significant variability in the amount follow-up

time between cases regardless of group. Cases that occurred early in the collection period would have longer follow-up time periods. As a result of the relatively short follow-up period compared with other studies, we do not feel that our study is designed to capture all potential complications in each patient cohort.

In addition, there were significant limitations with regard to the reporting of complications within this database. As a result, we were unable to determine whether there was a true difference in complications between the groups since the difference that we found could be a direct result of reporting inaccuracy. Alternatively, it was also expected that surgeons in the more experienced MOC group had gained a better understanding of their skills and were more adept at choosing the most medically appropriate patients for each operation.

CONCLUSION

In the current study, we observed a significant trend of increasing numbers of MPFLRs being performed in the ABOS group over the period of 2003 to 2017, while the number of cases in the MOC group remained stable. Last, despite significant limitations with regard to reporting complications, there was a significantly higher rate of complications reported by the less experienced ABOS group (11%) compared with the more experienced MOC group (6.4%). These findings may be helpful in surgical decision making and education in patellofemoral instability.

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APPENDIX

TABLE A1
MPFLR Cases for the ABOS Part II and MOC Examinations by Geographical Region and Examination Year[a]

	Geographical Region							
Year	Midwest	Southeast	South	Southwest	Northeast	Northwest	Other	Total, n
ABOS Part II								
2003	12 (18)	9 (14)	9 (14)	14 (21)	20 (30)	1 (2)	1 (2)	66
2004	23 (27)	12 (14)	8 (9)	20 (24)	12 (14)	9 (11)	1 (1)	85
2005	14 (15)	13 (14)	16 (17)	16 (17)	29 (32)	0 (0)	4 (4)	92
2006	15 (18)	15 (18)	17 (20)	19 (23)	10 (12)	4 (5)	4 (5)	84
2007	11 (14)	15 (19)	14 (18)	18 (23)	11 (14)	9 (12)	0 (0)	78
2008	13 (13)	8 (8)	8 (8)	33 (33)	29 (29)	10 (10)	0 (0)	101
2009	17 (20)	2 (2)	15 (18)	22 (26)	16 (19)	10 (12)	2 (2)	84
2010	24 (26)	17 (18)	16 (17)	13 (14)	16 (17)	7 (7)	1 (1)	94
2011	25 (28)	12 (13)	17 (19)	16 (18)	15 (17)	3 (3)	1 (1)	89
2012	39 (34)	19 (17)	20 (17)	16 (14)	13 (11)	8 (7)	0 (0)	115
2013	33 (21)	19 (12)	36 (23)	32 (20)	22 (14)	13 (8)	2 (1)	157
2014	27 (17)	24 (15)	29 (18)	29 (18)	27 (17)	16 (10)	7 (4)	159
2015	65 (35)	20 (11)	32 (17)	45 (24)	15 (8)	7 (4)	0 (0)	184
2016	50 (30)	33 (20)	34 (20)	27 (16)	15 (9)	6 (4)	1 (1)	166
2017	21 (21)	19 (19)	25 (26)	19 (19)	11 (11)	3 (3)	0 (0)	98
Total	389 (24)	237 (14)	296 (18)	339 (21)	261 (16)	106 (6)	24 (1)	1652
MOC								
2010	54 (33)	17 (10)	13 (8)	28 (17)	30 (19)	20 (12)	0 (0)	162
2011	27 (23)	23 (19)	10 (8)	15 (13)	26 (22)	18 (15)	0 (0)	119
2012	51 (28)	22 (12)	35 (19)	35 (19)	30 (16)	12 (6)	0 (0)	185
2013	55 (24)	43 (19)	26 (11)	32 (14)	58 (25)	16 (7)	0 (0)	230
2014	32 (18)	28 (15)	31 (17)	24 (13)	40 (22)	27 (15)	0 (0)	182
2015	49 (26)	21 (11)	31 (16)	31 (16)	38 (20)	22 (11)	0 (0)	192
2016	45 (22)	52 (26)	27 (13)	32 (16)	29 (14)	18 (9)	0 (0)	203
2017	71 (31)	36 (16)	48 (21)	30 (13)	26 (11)	15 (7)	1 (0)	227
Total	384 (26)	242 (16)	221 (15)	227 (15)	277 (18)	148 (10)	1 (0)	1500

[a]Data are presented as No. of cases (%) unless otherwise indicated. ABOS, American Board of Orthopaedic Surgery; MOC, maintenance of certification; MPFLR, medial patellofemoral ligament reconstruction.