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Short-term surgical complications following fast-track medial unicompartmental knee arthroplasty

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Aims

Medial unicompartmental knee arthroplasty (mUKA) is an advised treatment for anteromedial knee osteoarthritis. While long-term survival after mUKA is well described, reported incidences of short-term surgical complications vary and the effect of surgical usage on complications is less established. We aimed to describe the overall occurrence and treatment of surgical complications within 90 days of mUKA, as well as occurrence in high-usage centres compared to low-usage centres.

Methods

mUKAs performed in eight fast-track centres from February 2010 to June 2018 were included from the Lundbeck Foundation Centre for Fast-track Hip and Knee Replacement Database. All readmissions within 90 days of surgery underwent chart review and readmissions related to the surgical wound or the prosthesis were recorded. Centres were categorized as high-usage centres when using mUKA in ≥ 20% of annual knee arthroplasties. The occurrence of complications between high- and low-usage centres were compared using Fisher's exact test.

Results

We included 3,757 mUKAs: 2,377 mUKAs from high-usage centres and 1,380 mUKAs from low-usage centres. Surgical complications within 90 days occurred in 69 cases (1.8%), 45 (1.9%) in high-usage centres and 24 (1.7%) in low-usage centres (odds ratio (OR) 1.1 (95% confidence interval (CI) 0.65 to 1.8)). The most frequent complications were periprosthetic joint infections (PJIs) (n = 18; 0.48%), wound-related issues (n = 14; 0.37%), and periprosthetic fractures (n = 13; 0.35%). Bearing dislocations (n = 7; 0.19%) occurred primarily in procedures from high-usage centres. In high-usage centres, seven periprosthetic fractures (0.29%) occurred compared to six (0.43%) in low-usage centres (OR 0.68 (95% CI 0.20 to 2.0)). In high-usage centres, nine PJIs (0.38%) occurred compared to nine (0.65%) in low-usage centres (OR 0.58 (95% CI 0.22 to 1.6)).

Conclusion

Surgical complications are rare after fast-track mUKA surgery and with no difference in overall occurrence of surgical complications between high- and low-usage centres, although the risk of some specific surgical complications may favour high-usage centres.

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Introduction

Medial unicompartmental knee arthroplasty (mUKA) is an advised treatment for anteromedial knee osteoarthritis (OA). Compared to total knee arthroplasty (TKA), mUKA offers lower perioperative morbidity and mortality, faster recovery, better patient satisfaction, and shorter length of stay.[1-3] However, registry data suggest a higher risk of revision in mUKA, while smaller cohort studies find revision rates similar to TKAs.[4,5] While long-term revisions of mUKAs are well described,

there are varying reports on incidences of short-term complications inherent to mUKAs, such as bearing dislocations or periprosthetic fractures (PPFs) at the tibial plateau.[6]

The use of correct indications is crucial to reduce the risk of revision.[6] Current indications are less restrictive and only relate to the pathology of the knee OA.[7] Therefore, around 50% of knee OA patients are potential candidates for a mUKA, allowing for a high usage of mUKAs. It has been demonstrated that surgeons should use mUKA in at least 20% of knee arthroplasties in order to reach acceptable survivorship.[8] mUKA usage of at least 20% on a centre level is similarly associated with better survival.[9] Yet, the national joint registry in the UK and in Australia report less than 10% of knee arthroplasties to be mUKAs in 2019,[10,11] while the Danish Knee Arthroplasty Register (DKAR) report 22% of knee arthroplasties to be mUKAs in 2019.[12] While the importance of mUKA usage in relation to survival and long-term revisions has been investigated, further knowledge on the impact of usage on short-term surgical complications is needed.

The primary aim of this study was to investigate the occurrence of 90-day surgical complications after fast-track medial mUKA based on data from the Lundbeck Foundation Centre for Fast-track Hip and Knee Replacement Database (LCDB). The secondary aim was to investigate differences in the occurrence of 90-day surgical complications and their treatment between high-usage surgical centres and low-usage surgical centres. Previous studies on length of stay, overall readmissions, and mortality after mUKA from the LCDB collaborative group have reported on the cohort used in this study,[13,14] but the occurrence of specific surgical complications after medial mUKA and the effect of mUKA usage on complications has not yet been evaluated.

Methods

This study is a retrospective cohort study investigating the occurrence of 90-day surgical complications after fast-track mUKAs, and differences in complications between mUKAs performed in high- and low-usage centres. The data originate from the LCDB, to which eight fast-track orthopaedic centres reported from 2010 to 2018. The fast-track protocol and the data collection of the LCDB centres have previously been described.[13,15] The LCDB uses data reported directly to the database which is linked to data from Danish administrative databases. A preoperative nurse-assisted questionnaire was used to collect data on comorbidities and demographic data. Patient-reported data on antidiabetic treatment, psychotropic medication, and potent anticoagulants (vitamin K-antagonists or novel oral anticoagulants) was cross-referenced to the Danish National Database for Reimbursed Prescriptions.[16] Length of stay (LOS) and the occurrence of 90-day readmissions were monitored using the Danish National Patient Registry (DNPR), with > 99% completeness of somatic admission to Danish hospitals.[17] Based on the data from the DNPR, a chart review was conducted in case of readmissions with minimum one overnight stay within 90 days from index surgery. The chart review collected information from discharge summaries and health records to establish the reason for the readmission. In case of surgical complications with multiple established treatment options, the treatment of the complication was noted.

All centres are dedicated to a fast-track protocol including preferred spinal anaesthesia, multimodal opioid-sparing analgesia, preoperative high-dose corticosteroids,[18] preoperative tranexamic acid, no drains, in-hospital-only medical thromboprophylaxis, and early mobilization without restrictions, and with full weight-bearing. The centres use functional discharge criteria and intended discharge to the patient's own home.[19] Tourniquet was used based on the surgeon's preference.

Patients. Of 4,337 primary elective unilateral mUKAs identified in the DNPR from 2010 to 2018, the LCDB includes 3,927 UKA procedures with completed questionnaires.[13] We included the 3,757 mUKAs in this study and excluded 170 lateral mUKAs. Of the 3,757 mUKAs, 249 patients were readmitted within 90 days, but in seven cases no health records were available to establish the reason for readmittance.

Outcome measures. High-usage centres were defined as centres performing mUKAs in ≥ 20% of their annual knee arthroplasties, and low-usage centres were defined as centres performing mUKAs in < 20% of their annual knee arthroplasties.[8] Data on the number of knee arthroplasties performed were available from the DNPR. Surgical complications were defined as being directly related to the surgical wound or the prosthesis. Surgical complications were divided into periprosthetic joint infections (PJIs), PPFs, suspected superficial wound infections, bearing dislocations, wound-related issues (dressing change or haematomas), manipulation under anaesthesia (MUA), and arthroscopic removal of cement. Treatment choices regarding PJIs were divided into the following: debridement, antibiotics, and implant retention (DAIR) – defined as soft-tissue debridement, use of antibiotics, and bearing exchange but no replacement of fixed components – or revision, defined as either two-stage revisions with spacers or single-stage with replacement of fixed components, including conversion to TKA or a revision prosthesis. Treatment choices regarding PPFs were divided into the following: conservative treatment, defined as any nonoperative treatment; reoperation, defined as operative treatment with open reduction and internal fixation (ORIF) of the fracture using plates or screws, without replacing fixed components; and revision, defined as operative treatment with replacement

Table I. Demographics and procedure characteristics. High-usage centres are defined as centres where ≥ 20% of annually performed knee arthroplasties in the surgical centre are medial unicompartmental knee arthroplasty (mUKA), and low-usage centres as centres where < 20% of annually performed knee arthroplasties in the surgical centre are mUKA.

Variable	Overall	High-usage	Low-usage
Total, n	3,757	2,377	1,380
Mean age, yrs (SD)	66.2 (9.2)	66.2 (9.2)	66.2 (9.4)
Mean BMI, kg/m^2 (SD)	28.8 (4.7)	28.9 (4.6)	28.8 (4.8)
Median length of stay, days (IQR)	1 (0 to 1)	1 (0 to 1)	1 (1 to 2)
Male n (%)	1,762 (46.9)	1,138 (47.9)	624 (45.2)
Year of surgery, n (%)			
2010 to 2012	497 (13.2)	389 (16.4)	108 (7.8)
2013 to 2015	1,502 (40.0)	1,005 (42.3)	497 (36.0)
2016 to 2018	1,758 (46.8)	983 (41.4)	775 (56.2)
Anaemia n (%)	566 (15.9)	319 (14.5)	247 (18.1)
Use of walking aid, n (%)			
No	3,311 (88.1)	2,108 (88.7)	1,203 (87.2)
Yes	380 (10.1)	216 (9.1)	164 (11.9)
Missing	66 (1.8)	53 (2.2)	13 (0.9)
Hypertension n (%)	1,976 (52.6)	1,303 (54.8)	673 (48.8)
Diabetes type, n (%)			
No DM/diet	3,421 (91.1)	2,163 (91.0)	1,258 (91.2)
Insulin-dependent DM	68 (1.8)	41 (1.7)	27 (2.0)
Non-insulin-dependent DM	268 (7.1)	173 (7.3)	95 (6.9)
Living situation, n (%)			
With others	2,818 (75.0)	1,824 (76.7)	994 (72.0)
Alone	899 (23.9)	533 (22.4)	366 (26.5)
Institution	6 (0.2)	4 (0.2)	2 (0.1)
Missing	34 (0.9)	16 (0.7)	18 (1.3)
Cardiac disease, n (%)			
No	3,269 (87.0)	2,039 (85.8)	1,230 (89.1)
Yes	480 (12.8)	335 (14.1)	145 (10.5)
Missing	8 (0.2)	3 (0.1)	5 (0.3)
Pulmonary disease, n (%)			
No	3,399 (90.5)	2,157 (90.7)	1,242 (90.0)
Yes	353 (9.4)	218 (9.2)	135 (9.8)
Missing	5 (0.1)	2 (0.1)	3 (0.2)
Psychiatric disease, n (%)	549 (14.6)	335 (14.9)	194 (14.1)
Potent antichoagulants, n (%)	164 (4.4)	110 (4.6)	54 (3.9)
Cemented prosthesis, n (%)	2,174 (57.9)	1,377 (57.9)	797 (57.8)

*Vitamin K-antagonists or novel oral anticoagulants.
DM, diabetes mellitus; IQR, interquartile range; SD, standard deviation.

of the fixed components, including conversion to TKA or a revision prosthesis.

Ethical approval. Data-gathering for the LCDB was approved by the Danish National Board of Health (3-3013-56/2/EMJO) and data storage was approved by the Danish Data Protection Agency (P-2019-709). No approval from a research ethical committee was required, according to Danish law, as this study was observational.

Statistical analysis. Continuous variables are evaluated for normality using qq-plots and histograms, and are reported depending on normality. Normally distributed variables are presented as a mean with a standard deviation (SD) and non-normally distributed variables are presented as a median with an interquartile range (IQR). Categorical variables are presented as counts, percentages, and where statistical tests are applied a 95% confidence interval (CI) is reported. Statistical analyses are aimed at determining differences in occurrence of complications between high- and low-usage centres using Fisher's exact test. The analyses are presented as odd ratios (ORs), 95% confidence intervals (CIs), and p-values. A p-value < 0.05 was considered significant. No adjusted analyses were conducted due to the rare occurrence of the complications and the cohort size. Data were analyzed using R-studio and R v. 3.6.1 (R Foundation for Statistical Computing, Austria).

Results

We included 3,757 mUKAs, of which 2,377 were performed in high-usage centres and 1,380 were

Table II. Surgical complications.

	mUKA, n (% (95% CI))				
Variable	**All**	**High-usage**	**Low-usage**	**OR (95% CI)**	**p-value***
Total, n	3,757	2,377	1,380		
Readmissions due to surgical complications	69 (1.8 (1.4 to 2.3))	45 (1.9 (1.4 to 2.5))†	24 (1.7 (1.1 to 2.6))	1.1 (0.65 to 1.8)	0.802
PJI	18 (0.48 (0.28 to 0.76))	9 (0.38 (0.17 to 0.72))	9 (0.65 (0.30 to 1.2))	0.58 (0.22 to 1.6)	0.327
DAIR	11 (0.29)	7 (0.29)	4 (0.29)		
Revision	7 (0.19)	2 (0.08)	5 (0.36)		
Periprosthetic fracture	13 (0.35 (0.18 to 0.59))	7 (0.29 (0.11 to 0.61))	6 (0.43 (0.16 to 0.94))	0.68 (0.20 to 2.0)	0.567
Conservatively treated	2 (0.05)	1 (0.04)	1 (0.07)		
Reoperation (ORIF)	6 (0.16)	2 (0.08)	4 (0.29)		
Revision	5 (0.13)	4 (0.17)	1 (0.07)		
Suspected superficial wound infection	8 (0.21 (0.09 to 0.42))	5 (0.21 (0.07 to 0.49))	3 (0.22 (0.04 to 0.63))	0.97 (0.24 to 4.7)	1.000
Bearing dislocation	7 (0.19 (0.07 to 0.38))	6 (0.25 (0.09 to 0.55))	1 (0.07 (< 0.01 to 0.40))	3.5 (0.47 to 79)	0.434
Wound-related issue	14 (0.37 (0.20 to 0.62))	11 (0.46 (0.23 to 0.83))	3 (0.22 (0.04 to 0.63))	2.1 (0.58 to 9.0)	0.279
Manipulation under anaesthesia	3 (0.08 (0.02 to 0.23))	3 (0.13 (0.03 to 0.37))	0	N/A	0.303
Arthroscopic removal of cement	5 (0.13 (0.04 to 0.31))	3 (0.13 (0.02 to 0.37))	2 (0.14 (0.02 to 0.52))	0.87 (0.14 to 7.0)	1.000

*Fisher's exact test.
†One of the 45 surgical complications in high-usage centres was a revision due to an increased valgus malalignment and lateral OA progression.
CI, confidence interval; DAIR, debridement, antibiotics, and implant retention; N/A, not applicable; OA, osteoarthritis; OR, odds ratio; ORIF, open reduction and internal fixation; PJI, periprosthetic joint infection; UKA, unicompartmental knee arthroplasty.

performed in low-usage centres. Across the study period, the mUKA usage among the eight centres ranged from 2.0% to 35.4%. The overall mUKA usage was 27.2% and 10.8% for high-usage centres and low-usage centres, respectively. Demographics and procedure characteristics are displayed in Table I. No major differences in patient characteristics are present between high-usage centres and low-usage centres.

In total, 69 readmissions within 90 days (1.8% (95% CI 1.4 to 2.3)) were caused by surgical complications from 2010 to 2018 (Table II). The overall odds of surgical complications within 90 days did not differ between high- and low-usage centres (OR 1.1 (95% CI 0.65 to 1.8)). Of the 69 surgical complications, 45 (1.9% (95% CI 1.4 to 2.5)) occurred in high-usage mUKAs and 24 (1.7% (95% CI 1.1 to 2.6)) occurred in low-usage mUKAs.

PPFs of the tibial plateau occurred in 13 mUKAs from 2010 to 2018 (0.35% (95% 0.18 to 0.59)). PPFs occurred in seven mUKAs from high-usage centres (0.29% (95% 0.11 to 0.61)) and in six mUKAs from low-usage centres (0.44% (95% CI 0.16 to 0.94); OR 0.68 (95% CI 0.20 to 2.0)). Of the total 13 PPFs, only two were managed conservatively, while six underwent ORIF and five underwent revision (Table II). Bearing dislocations occurred in seven mUKAs (0.19% (95% CI 0.07 to 0.38)) mUKAs, of which six occurred in high-usage centres (0.25% (95% CI 0.09 to 0.55)) compared to one in low-usage centres (0.07% (95% CI < 0.01 to 0.40)). PJIs occurred in 18 mUKAs (0.48% (95% CI 0.28 to 0.76)) of which nine (0.38% (95% CI 0.17% to 0.72%)) were from high-usage centres and nine (0.65% (95% CI 0.30 to 1.2)) were from low-usage centres (OR 0.58 (95% CI 0.22 to 1.6)). In low-usage centres, five of nine PJIs were revised compared to two of nine in high-usage centres. Furthermore, one of the 45 surgical complications in the mUKAs performed in high-usage centres was a revision to a TKA due to an increased valgus malalignment and lateral OA progression.

Data on the effect of usage on length of stay, day of surgery discharge, as well overall readmission and medical complications have been published elsewhere.[13]

Discussion

This study investigating surgical complications in 3,757 mUKAs found surgical complications resulting in readmission to occur in 1.8% of cases (n = 69). The most frequent surgical complications were PJIs (0.48%), wound-related issues (0.37%), and PPFs of the tibial plateau (0.35%). Of the included mUKAs, 2,377 were performed in high-usage centres and 1,380 were performed in low-usage centres. No difference in overall occurrence of surgical complications was present between high- and low-usage centres. However, PPFs and PJIs appeared to occur more frequently in low-usage centres, while bearing dislocations appeared to occur more frequently in high-usage centres. Surgical treatment options were used in 11 of 13 PPFs, with high-usage centres primarily using revision and low-usage centres using ORIF. PJIs were treated using DAIR in 11 of 18 cases, with high-usage centres primarily

using DAIR and low-usage centres tending to use revision (one- or two-stage revision).

We reported that PPFs of the tibial plateau occurred in 0.35% of mUKAs within 90 days of surgery. While PPFs after mUKA are commonly referred to as a rare complication,[6,20] previously published rates of PPFs differ substantially. A study of 212 mUKAs operated from 2015 to 2017 found that fractures occurred in 8% of patients within 180 days.[21] A study of 2,464 mUKAs found fractures to occur in 16 patients (0.6%) with a median of 35 days from surgery to fracture.[22] Reoperation with fixation of the fracture was the most frequent treatment option, followed by revision to TKA. This coincides with our findings. The risk of PPFs following mUKA is affected by multiple surgical and patient-related factors, i.e. the level of tibial resection, angle of the vertical tibial cut, limb alignment, and tibial shape.[6,21,23] Consequently, expertise in mUKA surgery is a prerequisite for the prevention of postoperative PPFs, potentially explaining the more frequent occurrence of PPFs in low-usage centres.

Bearing dislocations occurred in seven mUKAs within 90 days (0.19%), and six of these bearing dislocations occurred following mUKAs performed in high-usage centres. While the short-term occurrence of bearing dislocation is not widely reported, the reported long-term occurrence varies greatly between 0.4% and 2.9%.[24,25] A review of studies amounting to 8,658 mUKAs with a mobile bearing found an incidence of 0.58% for bearing dislocations.[26] A difference in occurrence of bearing dislocations between high-usage and low-usage centres could potentially be explained by differences in the use of mobile- and fixed-bearing mUKA designs, but data on bearing design was not available in the current cohort. However, reviewing the DKAR, only one of the low-usage centres has a history of using a fixed-bearing design in about 50% of mUKAs.[27] Other factors increasing the risk of bearing dislocations in mobile bearing designs are unbalanced flexion-extension gaps, suboptimal alignment of the tibial component, and impingement of the bearing on either bone or soft-tissue.[6] Since gap balancing and component alignment is dependent of surgical skill, it would be counterintuitive to suggest that surgeons at high-usage centres are less experienced mUKA surgeons. However, as the preoperative knee anatomy of the patients also influences the component positioning and gap balancing, a broader use of mUKA in high-usage centres might result in a higher frequency of use in knee OA patients with a preoperative knee anatomy more prone to bearing dislocations.

Our study offers detailed data on the incidence of specific short-term surgical complications after mUKA surgery in a fast-track setting, since all registered complications are based on chart-review of overnight readmissions supplied from the DNPR and not solely on diagnosis codes from administrative databases, contrary to larger register studies. Previous studies from the LCDB collaborative group have reported on this cohort, but with a focus on overall length of stay and readmissions. Considering the strengths of the data on readmissions from the LCDB, we decided to use the data to investigate the specific complications related to mUKA. Based on chart review, we also report the chosen treatment related to complications with multiple treatment options. However, when investigating differences between high- and low-usage centres regarding specific surgical complications following mUKA surgery, the statistical power of our study is challenged due to the low occurrence of complications. Therefore, indicated differences and similarities require larger investigations to be further established. However, all centres reporting to the LCDB are well-established arthroplasty centres dedicated to common fast-track protocol, which increases the uniformity of the centres. mUKA usage is often investigated on a surgeon level, but surgeon-specific data are not available. We therefore used centre-level mUKA usage, which has shown an association to mUKA revision similar to surgeon-level usage.[9]

In conclusion, we found that surgical complications within 90 days of fast-track mUKA surgery are rare. The most frequent short-term surgical complications leading to readmission following mUKA were PJIs (0.48%), wound-related issues (0.37%), and PPFs of the tibial plateau (0.35%). Our results indicate that the risk of PPFs and PJIs may favour high-usage centres, while bearing dislocations may favour low-usage centres.

Take home message

- Short-term surgical complications are rare when performing medial unicompartmental knee arthroplasty in a fast-track setting.
- The most frequent complications are periprosthetic joint infection, wound related issues, and periprosthetic fractures of the tibial plateau.

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- P. B. Petersen: Conceptualization, Methodology, Supervision, Data curation, Writing – review & editing.
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