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Second opinion and time to knee arthroplasty: a prospective cohort study of 142 patients

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ABSTRACT

Objective The objective of this study was to determine the impact of obtaining a second opinion consultation on time to knee arthroplasty (KA). We further examined the frequency of KA and the determinants of KA following the second opinion.

Design Prospective cohort study.

Setting The second opinion programme was implemented at the Ludwig Maximilian University Hospital in Munich.

Participants Participants comprised patients with knee osteoarthritis who were insured with one of the largest statutory health insurance Allgemeine Ortskrankenkasse Bayern (mean age 64.3±9.6 years). Patients participated in a second-opinion programme and completed questionnaires on site before and after personal presentation for the second opinion consultation. Follow-up questionnaires were delivered by post at 3 and 12 months after the second opinion consultation. Of the 142 patients included in the study, 47 (33.1%) underwent KA within 12 months after obtaining the second opinion.

Primary outcome measures Primary outcome measure was time until patients received KA. Cox proportional hazard modelling was used to calculate the associations between the selected predictors and time that elapsed between receipt of the second opinion to KA.

Results Mean time until KA was 17 weeks. Kaplan-Meier curves showed significant differences in time to KA according to the recommendation given at second opinion consultation, knee-related quality of life and Kellgren-Lawrence grade. In multivariate Cox proportional hazard modelling, second opinion recommendation (HR 5.33, 95% CI 1.16, 24.41) and knee-related quality of life (HR 1.03, 95% CI 1.01, 1.06) were significant predictors of time from second opinion to KA.

Conclusions Obtaining a second opinion had significant impact on time to knee replacement. Those who were recommended immediate surgery also underwent surgery more quickly after the second opinion. The effect of knee-related quality of life supports the importance of patient-reported outcome measures in the decision for or against KA.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The follow-up period of 12 months after receipt of second opinion is longer than that implemented in previous studies.
⇒ Multilevel fractional polynomial modelling using backward selection was used to identify stable significant predictors by running the model in multiple samples.
⇒ A multivariate Cox proportional hazards model was used to determine the associations between predictors and receipt of knee arthroplasty (KA).
⇒ The lack of a control group prohibits firm conclusions regarding the reduced frequency of KA.

INTRODUCTION

Among patients with knee osteoarthritis (OA), 30% undergo knee arthroplasty (KA) during their lives.[1] Research has demonstrated that KA is two times as effective at reducing pain and improving function compared with non-surgical treatment in patients with end-stage OA.[2] However, this should be weighed against the risk of complications, given that an estimated 5.7% of patients suffer severe adverse events after KA, including venous thromboembolism, genitourinary and respiratory complications, and local joint infection.[3] Furthermore, 13%–19% of patients report dissatisfaction with their long-term functional outcomes after KA.[4 5]

Consideration of the benefits and risks of KA often causes uncertainty for patients, as reflected in many patients' desire to obtain a second medical opinion from another physician. In one representative survey of the German population, 56% of respondents considered it important to have obtained a second opinion from a medical professional prior to undergoing orthopaedic surgery.[6]

Previous studies have detected significant disagreement between first and second opinions; for example, in voluntary second opinion programmes for knee surgery, between 40% and 74% of patients received opposing opinions.[7–9] Both individual patients and healthcare systems may benefit from second opinion programmes. A previous evaluation of the second opinion programme presented here showed reduced patient uncertainty in terms

of their decisions as to whether to undergo KA following receipt of the second opinion.[8] Another second opinion programme with no direct contact between the specialist and the patient reviewed the effect of second opinions. Their findings suggest second opinions lead to more conservative treatment recommendations and thus have the potential to reduce the healthcare costs.[10] Patients in previous studies have reported that second medical opinions exert a significant influence on their treatment decisions.[8 11 12] However, to the best of our knowledge, no previous study has investigated the contribution of the second opinion recommendation to patients' decision to undergo KA at 1 year after consultation.

In this prospective cohort study, we aim to examine the impact of a second opinion recommendation on the frequency of subsequent KA during the subsequent 12 months. We also examine the other determinants contributing to positive KA decisions after a second opinion.

MATERIALS AND METHODS

Study design

In this prospective cohort study, data were collected from patients who hold statutory health insurance policies with Allgemeine Ortskrankenkasse (AOK) Bayern, which is among Germany's largest and most popular statutory health insurance providers. All patients participated in a second opinion programme following receipt of a KA surgery recommendation.

Setting

The medical second opinion programme was implemented at the Ludwig Maximilian University (LMU) hospital in Munich in 2016. An Endocert-certified specialist in KA provided the patients with their second opinion. Endocert is the world's first joint arthroplasty-specific quality assurance system for certifying the quality of knee and hip arthroplasty clinics.[13] At the end of 2018, there were 543 certified clinics in German facilities.

Data collection

Patients completed questionnaires before (T0) and after they received the second opinion (T1) on site in the clinic's waiting area during the study period from 7 October 2016 to 13 March 2020. Further details on data collection at T0 and T1 have been presented elsewhere.[8] For the follow-up questionnaires, preaddressed and stamped envelopes were sent to the patients by post at 3 months (T2) and 1 year (T3) after T0. A reminder postcard was sent 1 week after both T2 and T3. If the patients did not respond after 3 weeks, a study assistant called the patient by phone. All patients who returned a questionnaire were included in the study. Owing to delays in questionnaire completion, the total observation time for some patients exceeded 12 months.

It was not possible to blind the second opinion physician regarding the first opinion given that recommendation for KA by the first physician was an inclusion criterion for this medical second opinion programme.

Patient recruitment and inclusion criteria

Patient recruitment was undertaken by AOK Bayern, who informed their members about the second opinion programme via their website, Facebook page, members' magazine, telephone contacts and office branches. Patients willing to receive a second opinion called the hospital for a consultation appointment. Staff members informed patients about the possibility of opting into the study. Only AOK members who had previously been recommended to undergo (unicondylar or bicondylar) KA by an orthopaedic surgeon were included in the programme. Further criteria for inclusion in the study were a previous x-ray image of the knee in two planes from within the last 6 months and sufficient German language skills to complete the questionnaires. Patients were excluded if they had a previous recommendation for cartilage transplantation, a previous recommendation for arthroscopic meniscus surgery, or 'knee pain of unknown origin'. Eligibility for a second opinion consultation was based on the patients' insurance status at AOK Bayern. Owing to the study's exploratory nature, we included all eligible patients and did not perform a sample size calculation.

Measures

The second opinion physician's recommendation was assessed with the question, 'Did your second opinion doctor recommend KA?'. The response options were 'yes, now' (ie, surgery recommended immediately or within 3 months), 'later' (ie, later surgery recommended depending on the course of the disease) and 'no'.

Knee-specific health status was measured using the Knee Injury and Osteoarthritis Outcome Score (KOOS).[14] This patient-related outcome measure consists of five dimensions: pain (9 items), symptoms (7 items), activities of daily living (17 items), sport and recreation function (5 items) and knee-related quality of life (4 items). Each question includes five answer options that are scored from 0 to 4. For each dimension, the mean score is calculated and transformed into a score from 0 to 100.

Generic health status was measured using the EuroQol Group Five-Dimension Self-Report Questionnaire (EQ-5D-5L).[15] This instrument assesses the following five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression, with five answer options within each dimension. An index score was calculated using validated index scores. The index score can range from −0.661 (worst health) to 1 (best health).[16] The instrument also contains a visual analogue scale (EQ VAS), with the maximum rating score 100 labelled 'the best health you can imagine' and the minimum rating score of 0 labelled 'the worst health you can imagine'

The radiological severity of OA was assessed using the Kellgren-Lawrence grading system.[17 18] The physician determined the Kellgren-Lawrence grade during the

second opinion consultation based on their assessment of the patient's knee X-ray. The grading ranges from 0 to 4 (none, doubtful, minimal, moderate and severe OA). According to the German S2k (consensus-based) guideline 'Indications for knee endoprosthesis' from the Association of the Scientific Medical Societies in Germany, patients who are recommended for KA should have a Kellgren-Lawrence grade of 3 or 4.[19] Patients with a higher Kellgren-Lawrence grade benefit more from KA than patients with lower grades.[20]

Statistical methods

Potential variables associated with the frequency of KA within 12 months after the second opinion were selected from a database that was installed to evaluate this second opinion programme. These variables included whether the patient received a second opinion recommendation, KOOS pain score, KOOS symptoms, KOSS activities of daily living, KOOS sport and recreation, KOOS knee-related quality of life, EQ-5D-5L Index, EQ VAS, radiological severity of OA (Kellgren-Lawrence grade), body mass index (BMI), gender, age and education level. These variables were selected based on evidence from previous studies and clinical guidelines criteria for the indication of KA.[19 21–23]

Univariate analysis of predictors of KA

Univariate analysis was performed to assess the statistical significance of several variables that are potentially associated with KA using Pearson's χ^2 test for categorical variables and the Mann-Whitney U test for continuous variables. The Kellgren-Lawrence grade was dichotomised due to low cell counts. Kellgren-Lawrence grades 1 and 2 were collapsed into the category 'low level of osteoarthritis' and grades 3 and 4 into the category 'high level of osteoarthritis'.

Univariate survival analysis

For univariate survival analysis, the variable 'second opinion recommendation' was selected a priori as the primary independent variable of interest. The variables 'KOOS quality of life' and 'Kellgren-Lawrence grade' were selected for the final model of the survival analysis because these two variables showed the strongest associations with receipt of KA aside from the second opinion recommendation in the univariate comparison of patients who did and did not undergo KA. Date of second opinion (T0) was used as the starting time in the survival analysis. The event of interest was the date when the patients underwent KA. Time to event was calculated in weeks. The time until KA was graphically illustrated for subgroups using Kaplan-Meier curves. In this context, KOOS quality of life was transformed into a binary variable. Patients below the median score of 75 were assigned to the group with good quality of life, and patients above the score were labelled as having poor quality of life. Patients lost to follow-up were censored at their last follow-up. Patients who had not had surgery at the end of the study were also censored.

Multivariate analysis

Candidate variables for multivariate analysis were those that showed significant associations ($p<0.05$) in the univariate analysis. To avoid multicollinearity, the KOOS scales and the EQ-5D-5L were tested for correlation. Missing data were not imputed.

Cox proportional hazard modelling using listwise deletion was used to obtain the associations between the selected potential predictors and receipt of KA, presented as an HR with a 95% CI. The proportional hazards assumption was statistically and graphically checked based on the scaled Schoenfeld residuals. The independence between residuals and time was approved for each covariate and globally by a non-significant relationship. A p value<0.05 was considered significant.

Multilevel fractional polynomial modelling using backward selection was applied to identify stable significant predictors by running the model in multiple samples. This is a flexible method that is used to model nonlinear and asymmetric relationships. It uses backward elimination and allows for the re-inclusion of already excluded variables and the transformation of variables.[24–26]

In the model, the variable 'KOOS quality of life' was divided by 100 in the fractional polynomial transformation. The model did not reveal any other necessary transformation, thus indicating a linear relationship. For enhanced interpretability of the results, the results of the Cox regression without fractional polynomials were used for the final interpretation.

In the sensitivity analyses, the final model was controlled for gender and age. We also considered the potential impact of the COVID-19 pandemic on the results. Restrictions affecting KA began in March 2020. Dichotomised variables on the time of recruitment 3, 6 and 9 months before March 2020 were created (coded 1 'recruited during the defined period before March 2020' or 0 'recruited earlier than the defined period before March 2020'). These variables were added separately to the final model.

All statistical analyses were conducted using R Statistical Software, V.1.4.1106, for MacOS. We used the Strengthening the Reporting of Observational Studies in Epidemiology cohort checklist when writing our report.[27]

RESULTS

Study participants

In total, 142 patients were included in the analysis (figure 1). The mean age was 64.3 years (±9.6 years), and

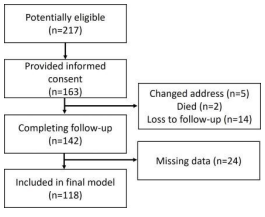

Figure 1 Flow chart of included participants.

Table 1 Characteristics of the study population

	All patients (n=142)	Patients with KA (n=47)	Patients without KA (n=95)	P value
Gender, male, n (%)	76 (53.5%)	25 (53.2%)	51 (53.7%)	1.000
Age, years, mean±SD	64.3±9.6	65.5±8.5	64.6±10.1	0.620
BMI, kg/m^2, mean±SD	28.6±5.6	29.9±5.1	28.4±5.9	0.481
Education, highest degree, n (%)				0.285
No degree	1 (0.7%)	0 (0%)	1 (0.1%)	
Basic school (8–9 years of education)	78 (56.9%)	24 (52.2%)	54 (59.3%)	
Middle school (10 years of education)	38 (27.7%)	14 (30.4%)	24 (26.4%)	
High school (12–13 years of education)	8 (5.8%)	2 (4.3%)	6 (6.6%)	
University	12 (8.8%)	6 (13.0%)	6 (6.6%)	
KA recommended, n (%) (n=142)				**<0.0001**
No	32 (22.5%)	3 (6.4%)	29 (30.5%)	
Later	54 (38.0%)	14 (29.8%)	40 (42.1%)	
Yes, Now	56 (39.5%)	30 (63.8%)	26 (27.4%)	
KOOS, mean±SD				
Pain (n=137)	52.8±19.1	59.6±15.9	49.5±19.7	**0.007**
Other symptoms (n=140)	46.9±20.3	52.8±18.6	43.8±20.5	**0.009**
Activities of daily living (n=141)	44.7±21.1	49.8±20.6	42.1±21.0	**0.046**
Sport and recreation (n=137)	70.9±22.4	77.5±22.2	67.5±21.8	**0.006**
Quality of life (n=140)	71.2±16.2	77.5±14.7	67.9±16.1	**<0.0001**
EQ-5D-5L Index, mean±SD (n=142)	0.7±0.3	0.5±0.3	0.7±0.2	**<0.0001**
EQ VAS, mean±SD (n=142)	61.5±19.2	59.1±21.6	62.9±18.3	0.509
Kellgren-Lawrence grade, n (%) (n=140)				**<0.0001**
1=doubtful osteoarthritis	7 (5.0%)	0 (0%)	7 (7.4%)	
2=minimal osteoarthritis	32 (22.9%)	5 (10.9%)	27 (28.7%)	
3=moderate osteoarthritis	65 (46.4%)	25 (54.3%)	40 (42.6%)	
4=severe osteoarthritis	36 (25.7%)	16 (34.8%)	20 (21.3%)	

P value for group differences, χ^2 test performed for categorical variables and Mann-Whitney U test for continuous variables, significant results in bold.
EQ-5D-5L Index score can range from min=−0.661 (worst health) to 1 (best health); KOOS ranging from 0 (best) to 100 (worst).
BMI, body mass index; EQ-5D-5L Index, EuroQol Group Five-Dimension Self-Report Questionnaire; KA, knee arthroplasty; KOOS, Knee Injury and Osteoarthritis Outcome Score.

53.6% of the patients were male. Of the 142 patients who were included, 47 (33.1%) underwent KA before the T3 time point. Owing to missing data in relation to 24 participants, only 118 patients were included in the multivariate analysis. Non-responders did not differ from the participants with respect to patient demographics (mean age 63.9±11.7; 51% were female).

Univariate comparison of predictors of KA

Compared with the patients who did not undergo KA (non-surgical patients), more patients who underwent surgery before T3 had received a recommendation of 'yes, now' at the second opinion consultation (p<0.0001). They also had a higher OA level as indicated by their Kellgren-Lawrence grade (p<0.0001). No group differences were observed for BMI, gender, age or education (table 1).

The surgical patients had lower preoperative scores on all five KOOS scales with p values ranging from <0.0001 for quality of life to 0.046 for activities of daily living. They had worse generic health status on the EQ-5D-5L Index (p<0.0001). No group differences were observed for the EQ VAS (table 1). At T2, the significance of differences between the surgical patients and non-surgical patients disappeared owing to the surgical patients' improvements. More detailed information on the course of knee-specific health status and quality of life from baseline to 3-month follow-up is available online in online supplemental material 1.

Results of univariate survival analysis

For surgical patients, the mean time from T0 to surgery was 17 weeks (median 13 weeks). The second opinion recommendation, KOOS quality of life score and Kellgren-Lawrence grade were significantly associated with time to KA (table 2, figure 2).

Of those who received a second opinion of 'yes, now', 66.3% underwent surgery within the study period, at a

Table 2 Median time to surgery and percentage of patients undergoing knee arthroplasty

	Time to KA, weeks				
	Q1	Median	n	Patients with KA (%)	P value
Recommendation of second opinion physician					0.0030
No	NA	NA	27	11.1	
Later	43	57	46	53.4	
Yes, now	11	23	47	66.3	
KOOS quality of life					<0.0001
<75	NA	NA	53	17.8	
≥75	11	27	66	67.2	
Kellgren-Lawrence grade					<0.0001
Low level of osteoarthritis	NA	NA	34	14.7	
High level of osteoarthritis	12	57	86	56.3	

Low level of osteoarthritis: grades 1 or 2; high level of osteoarthritis: grades 3 or 4.
Median survival time: number of weeks until 50% of patients received KA.
Q1: first quartile; number of weeks until 25% of patients received KA.
KOOS ranging from 0 (best) to 100 (worst).
KA, knee arthroplasty; KOOS, Knee Injury and Osteoarthritis Outcome Score.

median time of 23 weeks until surgery (first quartile: 11 weeks). Of those who received a second opinion for 'later', 53.4% underwent surgery within the study time period, at a median time of 57 weeks (first quartile 43 weeks). Of those who received a second opinion of 'no', 11.1% underwent surgery.

Among those with low knee-related quality of life, 67.2% underwent surgery, compared with 17.8% of those with high quality of life. The Kellgren-Lawrence grade was also strongly associated with surgery. Among patients who had high OA levels, 56.3% underwent KA, compared with only 14.7% of patients who had low OA levels.

Multivariate analysis

Three variables that proved significant in the univariate analysis were included in the multivariate Cox model. These were the second opinion recommendation, KOOS quality of life score and Kellgren-Lawrence grade. The other KOOS scales and the EQ-5D-5L Index were not included in the model, because all KOOS scales and the EQ-5D-5L Index showed significant correlations (p<0.0001) with r values ranging from 0.39 to 0.79. From these scales, KOOS quality of life was chosen for the regression model because it showed the highest association with time to KA when the scales were entered separately into the model. The assumption of proportional hazards was supported for each covariate (p>0.05).

The likelihood of undergoing KA was 5.33 times higher for those who received a second opinion of 'yes, now' than for those who received a second opinion of 'no' (HR 5.33, 95% CI 1.16, 24.41). Regarding quality of life, for every one-unit increase in the KOOS quality of life score, the likelihood of undergoing KA increased by 3% (HR 1.03, 95% CI 1.01, 1.06). The Kellgren-Lawrence grade was not a significant predictor of time to KA on multivariate analysis (HR 1.69, 95% CI 0.52, 5.56, p=0.38) (table 3).

Sensitivity analyses

BMI, gender and age added as single or combined independent variables to the final model were not associated with KA frequency. Adding these variables did not change the significance of the predictive variables. The sensitivity analysis concerning the impact of the COVID-19 pandemic on time to KA showed that patients recruited 6 months before March 2020 underwent surgery more quickly after recruitment than patients who were recruited earlier (HR 2.44, 95% CI 1.18, 5.02). Adding this variable to the model did not change the significance of the other predictive variables.

In another multivariate model, pain was added in recognition of the fact that pain is an important factor for the recommendation of KA.[19 21] In this model, the significant effect of pain, which was observed in the separate model without quality of life, became non-significant.

DISCUSSION

Key results

To the best of our knowledge, this is the first study to follow patients who have received recommendations for KA for 1 year after their consultation with a second opinion physician. One-third of the patients underwent KA surgery during the observation period. The second opinion recommendation and knee-related quality of life predicted time to surgery.

The significant influence of the second opinion on patients' decision to undergo KA is indicated by an agreement of almost two-thirds between the recommendation for timely surgery and the frequency of KA. More than half of these patients underwent surgery within 6 months after the recommendation. By contrast, only 11% of those who were advised against KA underwent surgery during the observation period. Patients who received a 'yes, now'

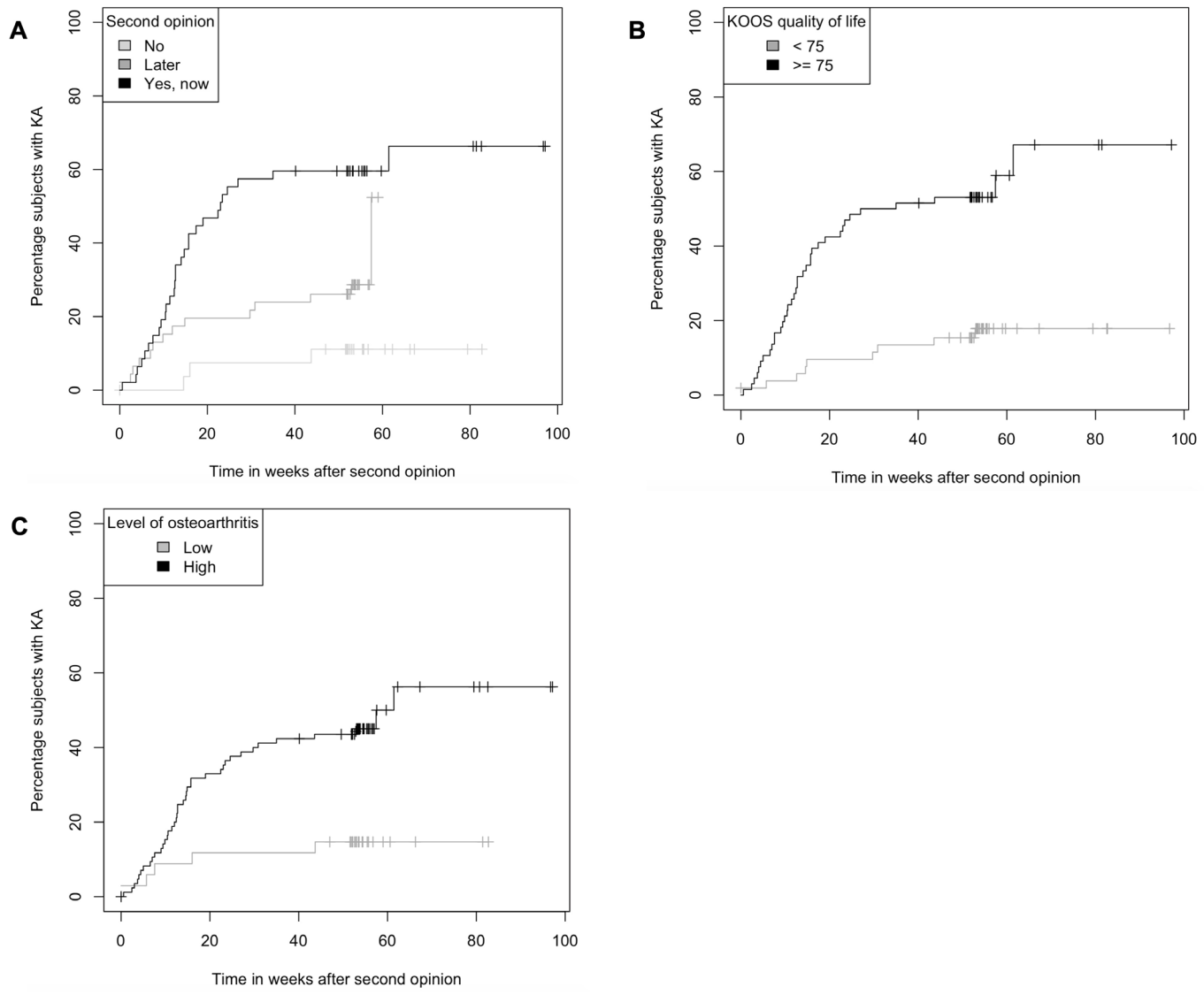

Figure 2 Kaplan-Meier plots of time to knee arthroplasty for different patient groups. Patients with different recommendations for surgery (A); patients with low and high knee-related quality of life (B); patients with low and high Kellgren-Lawrence grade (C). Censoring is indicated by small ticks. KA, knee arthroplasty; KOOS, Knee Injury and Osteoarthritis Outcome Score.

recommendation underwent surgery more frequently than patients who received a recommendation of 'later'.

The incidence of 33% of patients receiving KA was only slightly higher than the incidence of KA in the total population of patients with knee OA in the study by Burn *et al*.[1] However, it is to be expected that some of the patients who participated in the study will undergo KA at some later stage in the course of their lives. Accordingly, the lifetime risk of undergoing KA in this population with previous recommendations of KA is likely to be considerably higher than that in the total population of patients with knee OA.

Study findings in context

Low knee-related quality of life was a significant predictor in this study. This corroborates a previous large-scale case–control study that implemented a 108-month follow-up that selected matched patients with and without KA from the osteoarthritis initiative.[22] In that study, quality of life showed the fourth strongest risk association with KA after radiological risk of OA progression, Kellgren-Lawrence grade and BMI.

Further associations of patient-related outcome measures with KA have also been reported in the literature. In a large-scale prospective population-based cohort study of patients with knee or hip OA, the total scores of the Western Ontario and McMaster Universities Osteoarthritis Index at baseline predicted later joint arthroplasty.[21] In a cohort study of patients with end-stage knee OA, self-reported restrictions in activities of daily living predicted KA.[23] The results of a large-scale case–control study suggest that knee-specific quality of life is a stronger predictor than pain for KA,[22] as it was in this study.

The multivariate analysis detected no significant association between radiological severity of knee OA and

Table 3 Multivariate Cox proportional hazards model of knee arthroplasty predictors (n=118)

Covariates	HR	95% CI		P value
Second opinion decision				
No	Reference			
Later	3.116	0.695	13.96	0.138
Yes, now	5.331	1.164	24.41	0.031
KOOS quality of life	1.034	1.0121	1.057	0.002
Kellgren-Lawrence grade				
Low level of osteoarthritis (grade 1 or 2)	Reference			
High level of osteoarthritis (grade 3 or 4)	1.694	0.517	5.556	0.3844

Low level of osteoarthritis: grades 1 or 2; high level of osteoarthritis: grades 3 or 4.
Likelihood ratio test: $\chi^2(4)=30.75$, $p<0.0001$.
KOOS scores ranging from 0 (best) to 100 (worst).
KOOS, Knee Injury and Osteoarthritis Outcome Score.

frequency of KA on multivariate analysis. This contrasts with the results of previously published research. In one large case–control study, radiological severity was the strongest predictor of KA.[22] In a 10-year follow-up study after KA, patients with Kellgren-Lawrence grade 4 were 5.3 times more likely to receive KA than those with Kellgren-Lawrence grade 3.[28] However, the discrepancy between these studies and the present study may be explained by the strong association between the second opinion recommendation and the Kellgren-Lawrence grade here. This association echoes the findings reported in a previous evaluation study of this second opinion programme.[8]

According to the univariate analysis, only 5 out of 37 patients with a Kellgren-Lawrence grade of 1 or 2 underwent KA. This result suggests that unnecessary KA may be avoided through this second medical opinion, because according to the German S2k guideline 'Indications for knee endoprosthesis', KA is usually not appropriate for patients with grade 1 or 2 KA.[19] Only a small minority of patients decided against the recommendation given in the second opinion.

Age was not associated with KA. This contradicts other studies on predictors that evaluated patient cohorts more than 10 years ago.[21 23 28] The current trend to perform KA on younger patients may explain these differences compared with earlier studies.[29]

The lack of association between BMI and KA observed in this study is in agreement with a previous study that implemented a 2-year follow-up,[23] but it differs from previous studies with 6-year[21] and 9-year follow-up periods.[22] Accordingly, BMI appears to predict KA only after an observation period of longer than 2 years. Furthermore, the definition of obesity as a contraindication for surgery in recent years may contribute to this discrepancy compared with previous studies.[30]

The lack of association between gender and KA observed in this study agrees with the existing research on this topic.[21 23 28] The time between second opinion and KA depends on system-level factors, such as the healthcare system's referral protocol and the associated wait times for elective orthopaedic procedures.[31] Accordingly, the findings must be interpreted within the context of the country's healthcare ecosystem. If patients are recommended to undergo KA as soon as possible but have a long waiting time, this would bias the result. However, due to the low waiting time of less than 1 month for KA in Germany,[32] waiting time may not have affected this study's results.

The results of this study are comparable to other second opinion programmes that include consultation with a specialist in KA. The results may be generalisable to similar second opinion programmes for other elective orthopaedic surgery procedures, such as hip surgery. The generalisability of the results to second opinion programmes on online platforms remains unclear because the personal doctor–patient communication may have contributed to the long-lasting influence of the recommendation on the patient's decision.[12]

Strengths and limitations

This study followed patients for 1 year after second opinion consultation, thus implementing a robust longitudinal follow-up period. However, this observation period may be still too short to fully capture the effect of the second opinion and other predictors on frequency of KA, considering the time it can take before patients decide to undergo surgery. In another study that included patients with a previous KA recommendation, the frequency of KA increased to 60% at 5 years.[28] With a longer follow-up period, the association between the second opinion and frequency of KA may decrease somewhat, and the association with other variables, such as knee-specific quality of life, may increase.

A limitation of this study is that the restrictions imposed on elective orthopaedic surgery due to the COVID-19 pandemic that began in March 2020 may have impacted the availability and timing of KA surgery. However, the sensitivity analysis suggested that this did not affect the associations between predictors and patients' completion of KA.

Patients in this study are younger and include more males than is average among German patients receiving KA (64 vs 69 years; 54% male vs 39% male). However, they have a very similar mean BMI (29 vs 30).[33] The differences in age and sex limit the generalisability of the results.

Our study design did not include a control group, which limits the study's internal validity. Factors other than the second opinion may have caused the relatively low frequency of 33% patients who underwent KA. However, the lack of a control group should not affect the validity of the identified predictors.

CONCLUSIONS

In conclusion, this study demonstrated that in OA patients who received a second opinion consultation,

the physician's recommendation strongly predicted the length of time to KA. The independent predictor knee-related quality of life confirms the importance of patient-reported outcomes for the final decision as to whether or not to undergo KA. The rather low frequency of 33% patients who underwent surgery suggests that a second opinion may reduce the frequency of surgery. However, studies with a control group design are necessary to confirm the possible effect of a second opinion on the frequency of orthopaedic surgery.

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Contributors RK: statistical analyses; interpretation of results; drafting and revising all parts of the manuscript; overall content as guarantor. EG: conception and design of the study; interpretation of data; contribution to the revision of the draft. MM: conception and design of the study; contribution to the revision of the draft. JP: study design; acquisition of data; contribution to the revision of the draft. ACP: study design; contribution to the revision of the manuscript. MW: study conception and design; contribution to the interpretation of data; major contribution to the drafting and revision of the manuscript. All authors read and approved the final manuscript.

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