Health-Related Quality of Life after Total Knee Replacement or Unicompartmental Knee Arthroplasty in an Urban Asian Population

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\textbf{ABSTRACT}

\textbf{Objective:} To examine health-related quality of life (HRQoL) after total knee replacement (TKR) or unicompartmental knee arthroplasty (UKA).

\textbf{Methods:} Asian adult patients undergoing either TKR or UKA in a hospital in Singapore between 2001 and 2006 were interviewed before surgery and 6 and 24 months postoperatively to obtain demographic information and HRQoL scores using the Short Form-36 Health Survey (SF-36) and the Oxford Knee Score (OKS).

\textbf{Results:} Data were collected from 2243, 1715, and 1113 patients at baseline and at 6 and 24 months, respectively. TKR patients had a lower preoperative OKS than UKA patients and lower preoperative scores on four subscales of the SF-36 ($P < 0.01$). Both TKR and UKA patients' OKS and SF-36 subscale scores improved 6 months postoperatively except in the general health domain. SF-36 role physical and bodily pain scores showed the most improvement (40.9 and 33.0 points in TKR and 36.9 and 31.4 points in UKA patients, respectively). Two years after surgery, TKR patients' SF-36 scores and OKSs were not significantly different from those of UKA patients except for physical functioning scores. Multiple regression analysis adjusting for demographics showed that baseline scores were a significant predictor of the postoperative OKSs and scores on all SF-36 subscales ($P < 0.01$), whereas the type of surgery was not associated with the postoperative scores.

\textbf{Conclusions:} Both TKR and UKA patients experienced significant improvements in HRQoL, particularly in the role physical and pain domains. After controlling for potential confound-
Introduction

Osteoarthritis (OA) of the knee is a common cause of pain and functional limitations, and its prevalence increases with age among the elderly [1]. Given the aging of populations worldwide, particularly in developed countries, the prevalence of knee OA is increasing, leading to an increase in the demand for knee surgery.

Traditionally, knee surgery outcome has been evaluated by radiological data or surgeon assessment of joint function. These clinical evaluations include pain, stability, alignment, functional ability, and range of motion (ROM) [2]. Because patients’ perceptions of treatment outcomes may vary from clinicians’ judgments [3], measuring patients’ perspectives using health-related quality of life (HRQoL) instruments has become an important approach for outcome evaluation. Previous studies of knee replacement have shown substantial improvements in patients’ HRQoL scores for physical health after the surgery [4–7]. In particular, greater and faster improvements were noted in the pain dimension [4,5,8].

Current surgical treatments for knee OA patients include unicompartmental knee arthroplasty (UKA) and total knee replacement (TKR) [9]. Previous studies have shown that both surgical procedures are safe and effective [10,11]. Although UKA is effective in patients with knee OA restricted to a single compartment, TKR is recommended for patients with more extensive knee OA [9]. It is also noteworthy that UKA has the additional benefits of lower costs, shorter hospital stay, less invasiveness, quicker rehabilitation, and a potentially better cost-effectiveness profile [12–15].

Several studies have been conducted to directly compare the outcomes of TKR and UKA, which primarily focused on clinical outcomes, such as pain relief, ROM, and the Knee Society Score [16–23]. In most of these studies, TKR and UKA groups were comparable at baseline because either randomization or matching was performed [16,18–20,23]. Rougraff et al. [18] found that UKA was usually performed in patients with less severe arthritis, and thus better preoperative knee function. Compared with the TKR group, UKA patients experienced comparable or better postoperative outcomes, such as a better ROM and a lower reoperation rate [18]. A randomized clinical trial in patients suitable for unicompartmental replacement found that UKA had better performance on a few clinical measures than TKR, and this superiority was sustained for 5 years postoperatively [16]; in addition, the survivorship rate was comparable between UKA and TKR after 15 years of follow-up [23]. More recently, a matched-group study revealed that the UKA group had a greater mean postoperative active ROM but a lower 5-year joint survivorship rate than the TKR group [19]. In another matched paired study, Manzotti et al. [20] reported better functional results and a higher clinical rating score for UKA than computer-assisted TKR in the treatment of unicompartmental knee OA. Weale et al. [24] compared patients’ perceptions of knee OA, and their HRQoL scores were considered affected by both operations.

HRQoL instruments

The SF-36

The SF-36 is a commonly used generic health status questionnaire composed of eight subscales that measure physical functioning (PF), role limitations due to physical problems (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE), and mental health (MH) [27]. The scores of each subscale are normalized to a scale ranging from 0 to 100, with a higher
score reflecting a better health status. The SF-36 version 1 was used in this study.

The OKS
The OKS is a 12-item, patient-assessed questionnaire designed specifically for use in patients undergoing knee replacement surgery [28–30], and it has also been used in patients undergoing TKR [31–34] or UKA [35–37]. The OKS assessed an individual’s pain (e.g., usual level of knee pain, pain in bed at night) and physical disability (e.g., trouble walking down stairs, trouble with transport). Each item is scored from 1 (least difficulty/severity) to 5 (most difficulty/severity), and individual item scores are summed to yield an overall score ranging from 12 (no pain or limitation for all items) to 60 (severe pain or limitation for all items) [30].

Statistical analysis
Paired t tests were used to compare preoperative and postoperative scores on the OKS and all eight domains of the SF-36. Independent t tests were performed to examine the difference in the preoperative and postoperative scores between TKR and UKA patients and also the change in scores after surgery between these two groups of patients. Multiple linear regression was used to determine whether the type of surgery was independently related to the postoperative HRQoL scores after adjusting for major HRQoL determinants (age, sex, ethnicity, housing type, and respective baseline HRQoL score). The 6- and 24-month postoperative scores were used as dependent variables in separate regression models, whereas surgery type and the HRQoL determinants selected were used as the independent variables. All analyses were performed with PASW version 17.0. Given the multiple comparisons, P < 0.01 was considered significant.

Results
Data were collected from 2243, 1715, and 1113 patients at baseline and 6 and 24 months, respectively, yielding retention rates of 76.5% and 49.6%, respectively. Slightly more than one fifth of the patients (n = 527) underwent UKA.

Patient characteristics
As presented in Table 1, at baseline, 79.3% of the TKR and UKA patients were female, 88.7% were Chinese, and 76.3% lived in public housing. The mean age of patients was 66.1 years ± 8.1 years. A comparison of the TKR and UKA patients indicated that the two groups had similar demographic characteristics, except that on average the UKA patients were 4 years younger than the TKR patients (P < 0.001). The dropout rate was similar between the two surgery groups (P = 0.05 and P = 0.30 at the 6- and 24-month follow-ups, respectively).

SF-36 scores and OKS at baseline and follow-up
Table 2 presents the patients’ OKS and eight SF-36 subscale scores at baseline and follow-up. Before surgery, the TKR patients had a lower mean score than the UKA patients on four subscales of the SF-36 (PF, RP, BP, and SF), with the differences ranging from 5.2 to 10.3 points (P < 0.01). These differences remained statistically significant 6 months after surgery, but the magnitude became smaller, ranging from 4.0 to 7.6 points. Two years after surgery, the TKR patients’ SF-36 scores were only significantly lower than the UKA patients on the PF subscale. Similarly, the difference between the two groups on the OKS was 3.3 points at baseline, which decreased to one point 6 months after surgery, with no difference found 2 years after surgery.

Improvement in HRQoL after surgery
As shown in Table 3, the OKS and all the SF-36 subscale scores of both the TKR and UKA patients increased 6 months after surgery, except the general health scores of UKA patients. Compared with preoperative health status, among the SF-36 subscales, the most improvement in absolute scores was found in RP score, followed by BP score. The improvement in

| Table 1 – Baseline characteristics of patients undergoing TKR or UKA. |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Demographic     | Total (TKR+UKA) | TKR             | UKA             | P value*        |
|                 | (N = 2243)      | (n = 1716)      | (n = 527)       |                 |
|                 | No. | %   | No. | %   | No. | %   |                     |
| Sex             |     |     |     |     |     |     |                     |
| Male            | 463 | 20.6| 350 | 20.4| 113 | 21.4| 0.63                |
| Female          | 1779| 79.3| 1365| 79.5| 414 | 78.6|                     |
| Ethnicity       |     |     |     |     |     |     |                     |
| Chinese         | 1989| 88.7| 1522| 88.7| 467 | 88.6|                     |
| Malay           | 155 | 6.9 | 116 | 6.8 | 39  | 7.4 |                     |
| Indian          | 75  | 3.3 | 58  | 3.4 | 17  | 3.2 |                     |
| Other           | 23  | 1.0 | 19  | 1.1 | 4   | 0.8 | 0.86                |
| Housing type    |     |     |     |     |     |     |                     |
| Public          | 1712| 76.3| 1329| 77.4| 383 | 72.7|                     |
| Private         | 512 | 22.8| 374 | 21.8| 138 | 26.2|                     |
| Other           | 19  | 0.9 | 13  | 0.8 | 6   | 1.1 | 0.09                |
| Age in years, mean ± SD | 66.1 ± 8.1 | 67.1 ± 7.6 | 62.9 ± 8.8 | <0.001         |
* Comparison between TKR and UKA patients.
OKS and PF scores continued between 6 months and 2 years after surgery in both patient groups ($P < 0.01$), and TKR patients’ scores in the domains of VT, SF, GH, and MH also improved between the 2 follow-ups ($P < 0.01$). The TKR and UKA patients showed no difference in the improvement in health status as measured by the SF-36 between the baseline and the two postoperative follow-ups. TKR patients’ improvement in the OKS, however, was 2.2 and 3.0 points greater than that of the UKA patients between the baseline and the two follow-ups, respectively ($P < 0.001$).

**Predictors of postoperative SF-36 scores and OKS**

Multiple regression analysis showed that baseline scores were a significant predictor of the postoperative OKS as well as scores on all the SF-36 subscales ($P < 0.01$) (Table 4). After controlling for the covariates included in the model, the type of surgery was not associated with the postoperative SF-36 scores or OKS.

**Discussion**

The main finding of this study is that the observed differences in postoperative HRQoL scores between TKR and UKA patients were due to patient characteristics and preoperative HRQoL scores rather than the type of knee arthroplasty. The results are important because they provide useful information for clinical decision making in patients being considered for TKR or UKA. The strengths of this study are the relatively large

### Table 2 – SF-36 scores and OKS at baseline and follow-up.

<table>
<thead>
<tr>
<th></th>
<th>TKR, Mean (SD)</th>
<th>UKA, Mean (SD)</th>
<th>Comparison of TKR and UKA*</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Preop 6 months postop 2 years postop</td>
<td>Preop 6 months postop 2 years postop</td>
<td>Preop 6 months postop 2 years postop</td>
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<tr>
<td>SF-36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PF</td>
<td>33.1 (21.0)</td>
<td>59.7 (21.8)</td>
<td>65.2 (22.4)</td>
</tr>
<tr>
<td>RP</td>
<td>33.7 (42.1)</td>
<td>74.0 (39.9)</td>
<td>77.8 (38.3)</td>
</tr>
<tr>
<td>BP</td>
<td>38.0 (18.6)</td>
<td>71.1 (23.9)</td>
<td>73.9 (24.9)</td>
</tr>
<tr>
<td>GH</td>
<td>72.6 (20.0)</td>
<td>74.5 (19.7)</td>
<td>73.6 (20.7)</td>
</tr>
<tr>
<td>VT</td>
<td>64.5 (21.6)</td>
<td>70.5 (19.7)</td>
<td>72.0 (19.8)</td>
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<tr>
<td>SF</td>
<td>57.3 (35.3)</td>
<td>84.6 (27.4)</td>
<td>87.6 (26.9)</td>
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<tr>
<td>RE</td>
<td>77.6 (40.8)</td>
<td>93.0 (24.6)</td>
<td>93.0 (24.8)</td>
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<tr>
<td>MH</td>
<td>73.9 (20.0)</td>
<td>80.5 (15.7)</td>
<td>81.1 (16.9)</td>
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<tr>
<td>OKS</td>
<td>36.6 (8.0)</td>
<td>21.2 (6.5)</td>
<td>19.0 (5.9)</td>
</tr>
</tbody>
</table>

BP, bodily pain; GH, general health; MH, mental health; OKS, Oxford Knee Score; PF, physical functioning; postop, postoperatively; preop, preoperatively; RE, role limitations due to emotional problems; RF, role limitations due to physical problems; SF, social functioning, SF-36, Short Form-36 Health Survey; TKA, total knee arthroplasty; UKA, unicompartamental knee arthroplasty; VT, vitality.

* UKA patients’ scores minus TKR patients’ scores.
† $P < 0.01$.

### Table 3 – Improvement in SF-36 scores and OKSs after surgery.

<table>
<thead>
<tr>
<th></th>
<th>TKR*</th>
<th></th>
<th></th>
<th>UKA*</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Preop vs. 6 months postop (n = 1323)</td>
<td>Preop vs. 2 years postop (n = 859)</td>
<td>6 months vs. 2 years postop (n = 703)</td>
<td>Preop vs. 6 months postop (n = 383)</td>
<td>Preop vs. 2 years postop (n = 250)</td>
<td>6 months vs. 2 years postop (n = 192)</td>
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<td>SF-36</td>
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<tr>
<td>PF</td>
<td>26.2†</td>
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<td>7.4†</td>
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<td>38.7†</td>
<td>1.3</td>
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<td>34.3†</td>
<td>4.5</td>
</tr>
<tr>
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<td>33.0†</td>
<td>35.4†</td>
<td>1.6</td>
<td>31.4†</td>
<td>30.2†</td>
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</tr>
<tr>
<td>GH</td>
<td>1.9†</td>
<td>0.1</td>
<td>−2.2†</td>
<td>1.1</td>
<td>−2.6</td>
<td>−4.0</td>
</tr>
<tr>
<td>VT</td>
<td>6.0†</td>
<td>7.8†</td>
<td>3.0†</td>
<td>3.8†</td>
<td>6.8†</td>
<td>1.1</td>
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<tr>
<td>SF</td>
<td>26.4†</td>
<td>28.1†</td>
<td>4.1†</td>
<td>23.9†</td>
<td>23.1†</td>
<td>0.4</td>
</tr>
<tr>
<td>RE</td>
<td>16.1†</td>
<td>11.3†</td>
<td>−1.0</td>
<td>14.2†</td>
<td>12.1†</td>
<td>−0.2</td>
</tr>
<tr>
<td>MH</td>
<td>6.3†</td>
<td>7.9†</td>
<td>2.0†</td>
<td>6.1†</td>
<td>9.1†</td>
<td>2.3</td>
</tr>
<tr>
<td>OKS</td>
<td>−15.4†</td>
<td>−17.8†</td>
<td>−2.5†</td>
<td>−13.1†</td>
<td>−14.8†</td>
<td>−1.7†</td>
</tr>
</tbody>
</table>

BP, bodily pain; GH, general health; MH, mental health; OKS, Oxford Knee Score; PF, physical functioning; postop, postoperatively; preop, preoperatively; RE, role limitations due to emotional problems; RF, role limitations due to physical problems; SF, social functioning, SF-36, Short Form-36 Health Survey; TKA, total knee arthroplasty; UKA, unicompartamental knee arthroplasty; VT, vitality.

* n = the smallest number of patients involved in the analysis across all measures.
† $P < 0.001$.
‡ $P < 0.01$. 
sample size and standardized, prospective data collection. In addition, this is one of the few studies comparing patient-reported outcomes in TKR and UKA, and, to the best of our knowledge, the first of its kind conducted in an Asian population.

The results of the present study indicate that after controlling for baseline scores and demographic characteristics, the type of knee arthroplasty did not influence postoperative HRQoL scores at 6 months or 2 years of follow-up. Similarly, a previous study by Weale et al. [24] used the OKS to compare the postoperative outcomes of UKA (n = 31) and TKR (n = 130) from the patient’s perspective; no difference was found in individual item or overall postoperative OKSs between the two groups (all P values > 0.05). In their study, preoperative OKS scores were not collected, and the sample size was limited. The present study extends and confirms the initial observations of Weale et al. by using prospectively collected data at baseline and defined time points postoperatively in a much larger cohort of patients. Given that UKA has lower costs but higher rates of revision than TKR [14,38], our results contribute to the literature about the surgery outcomes from the patient’s perspective, which could aid physicians in their clinical decision making. Patients undergoing UKA may expect to have outcomes comparable to those of TKR patients, whereas UKA has the additional benefits of being less invasive and allowing patients to have a more normal knee by preserving bone stock and soft tissues. This study also demonstrated improvements in HRQoL in patients who underwent TKR or UKA, as shown by one generic and one knee-specific instrument. The changes in the SF-36 scores between baseline and 2 years after surgery indicated that the most substantial improvements were in the physical domains of HRQoL (RP, BP, and PF).

In addition, 5 domains (RP, BP, PF, SF, and RE) reached the proposed minimal clinically important difference (MCID) of 10 points [39] in both TKR and UKA patients, whereas the least improvement was observed in the domain of GH. If a more liberal MCID estimate of five points was used, the improvements in the domains of VT and MH were also clinically significant. The greatest improvement took place within the first 6 months after surgery, with additional improvement in the OKS and PF scores noted after 2 years. Similar findings have been reported in a recent study of TKR in which the major improvements were seen 6 months after the surgery and the greatest improvements were observed in the main physical domains (RP, PF, and BP) [39]. A review of HRQoL in TKR also found that the greatest improvement in HRQoL appeared within the first 3 to 6 months postoperatively, and improvement in mental and social health domains was less obvious [5].

The influencing factors other than surgery type on postoperative HRQoL scores were also examined in this study. It was found that better preoperative scores were a significant predictor of better postoperative scores across all HRQoL domains, whereas other factors such as sex and ethnicity were not consistently correlated with postoperative scores. This finding is consistent with those reported in previous studies of the determinants of outcomes after knee replacement [4,40–43]. Because UKA does not replace all compartments of the knee, it is usually performed in patients with less severe knee problems. Therefore, it would be expected that preoperatively the UKA group would have better physical functioning and less pain than the TKR group, which was observed in this study. Although the TKR group had slightly greater improvement in certain SF-36 subscale scores after surgery than the UKA group, the magnitude of differences failed to reach statistical or clinical significance. In addition, given that the MCID estimate for the OKS has not been developed yet [44], it was difficult to determine the clinical significance of the difference in improvement between TKR and UKA patients’ OKSs. Nevertheless, the MCID of four points was estimated for the OKS using the Cohen effect size of 0.5, and the difference in improvement between TKR and UKA patients did not reach the estimated MCID.

Compared with the general Singapore population aged 51 or older, at 2 years after surgery, both TKR and UKA patients reported poorer SF-36 scores for PF, RP, and BP, but were superior in the other five domains [45]. The results suggest that despite large postoperative improvements in physical domains, the study patients’ physical health remained worse
than that of the general population. One explanation for the findings could be the differences in patient characteristics such as comorbidities and the presence of arthritis in the contralateral knee. Despite the significant improvement, patients’ knees that underwent TKR or UKA still may not achieve the same functioning and movement as normal joints. In addition, patients with a chronic condition such as knee arthritis may have developed mental coping strategies and adjustments and thus scored higher in mental health domains than the general population. Furthermore, the different methods of questionnaire administration (self-administration in the Singapore norming study and interviewer administration in this study) may also have contributed the differences.

We recognize several limitations of this study. First, the generalizability of the findings may be limited because the study was conducted in only one hospital, and only the patients who could speak either English or Chinese were recruited. In addition, the 2-year retention rate is unsatisfactory, and its effect on the study results is unknown. However, compared with the patients who continued the study and were assessed postoperatively, those lost to follow-up had similar baseline OKSs and SF-36 scores and demographics in terms of age, sex, and ethnicity. In addition, to test the robustness of the results, we replaced the missing values in each domain with the perfect score, the lowest score, and the mean score of the surgery group (i.e., TKR or UKA), respectively, and repeated the regression analyses. The results were similar when the missing scores in each domain were replaced by the respective mean of the surgery group to which the patient belonged. Finally, as the independent variables included in the regression model were limited to those collected in the interview, the impact of other potential confounders, such as education level, on the study results could not be examined.

**Conclusion**

Both TKR and UKA patients experienced significant improvements in HRQoL as measured by the OKS and SF-36, particularly in the physical domains. After controlling for demographics and preoperative scores, the type of surgery was not related to patients’ postoperative HRQoL scores.

**References**


