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Early Recovery following Total and Unicompartmental Knee Arthroplasty assessed using Novel Patient-Reported Measures.

Abstract

Background

The early post-operative recovery period following Unicompartmental (UKA) and Total Knee Arthroplasty (TKA) is an important area for research with increasingly sensitive metrics and new technologies. This study uses two recently developed patient-reported scores to compare the recovery following UKA and TKA.

Method

Two consecutive cohorts of 37 UKA and 33 TKA completed the Oxford Arthroplasty Early Recovery Score (OARS) and the Oxford Arthroplasty Early Change Score (OACS) on day 1, 2, 3, 7, 14 and week 6. The Short Form-36 (SF-36v2) was also completed week 1, 2 and 6. Improvements within cohorts and comparisons between cohorts were assessed.

Results and Discussion

For both UKA and TKA the speed of recovery was rapid early on and then progressively decreased. At all timepoints, the UKA cohort reported similar or significantly better scores than the TKA cohort. The overall OARS ($p<0.001$) showed that UKA recovered, shown improvement on the OARS, two to three times faster than TKA. OARS subscales demonstrated that UKA had better Function/Mobility ($p=0.003$) particularly early in the recovery, and better Nausea/Feeling Unwell ($p<0.001$) and Fatigue/Sleep ($p=0.009$) later in the recovery. UKA also had less pain at 2 weeks ($p=0.03$). There was no significant difference between UKA and TKA OACS. UKA had significantly better scores in three of the eight SF-36 domains, with the largest difference being in Role-Emotional ($p=0.003$).

Conclusion

The OARS is useful for the assessment of postoperative recovery. This study provides direct evidence that recovery following UKA is better and two to three times faster than following TKA. All differences may be explained by the less invasive nature of UKA.

Keywords (max 6): Recovery, Knee, Unicompartmental, Total, OARS, SF36

Introduction

Unicompartmental Knee Arthroplasty (UKA) is an established treatment option increasingly used for managing end-stage knee arthritis of one compartment of the knee. Total knee arthroplasty (TKA) is performed for patients with symptomatic, end-stage arthritis of one or more compartments of the knee. In appropriately selected patients, it has significant advantages over TKA, including better function, significantly lower morbidity and mortality [1] and indirect evidence of a faster recovery [2, 3].

The post-operative care pathway for a UKA is based on and highly similar to that of TKA. This includes a period of stay in hospital for immediate post-operative recovery and assessment of patient health and potential complications, followed by discharge and subsequent visits for physiotherapy and recovery assessment. In this period, the mechanical differences of a UKA compared to a TKA, as well as reduced surgical trauma to bone and soft tissues, may potentially influence a patient's ability to adapt to pain and load-bearing, and thereby cause UKA to have an inherently different post-operative recovery profile than TKA. These recovery profiles are not well quantified. A better understanding of recovery over time and differences between UKA and TKA, will enable optimising the patient recovery pathway, which benefits both patient satisfaction and healthcare costs [4, 5].

Patient reported outcome scores currently used for TKA and UKA assessment are built around assessing the impact of knee pain and function during activities of daily living. These are suboptimal for postoperative assessment: After the operation the patients tend to feel unwell. The early postoperative period involves abnormally limited mobility, increased pain and complication risk, and prescribed physiotherapy regimes [6] which do not emulate normal lifestyle and daily living. The early recovery period can be approximated as the time of surgery through to six weeks postoperatively [7]. Until recently, there were no effective and validated dedicated tools built to assess early postoperative UKA recovery [8, 9]. Other traditional orthopaedic measures do exist, including Knee Society Score (KSS) [10], Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [11], Knee Injury and Osteoarthritis Outcome Score (KOOS) [12] , Oxford Knee Score (OKS) [13], as well as newer scores including the Forgotten Joint Scores (FJS) [14] and Patient-Reported Outcomes Measurement Information System (PROMIS) [15]. However as mentioned above, none of these scores have been validated for use in the early post-operative period following UKA or TKA. This has likely contributed to the absence of an effective quantitative measurement of recovery of knee arthroplasty patients.

Two new scores have now been developed and validated to assess early postoperative recovery following lower limb arthroplasty [16]. They were designed to assess the symptoms, both systemic and joint related, that patients have during both this period. The Oxford Arthroplasty Early Recovery Score (OARS) is a 14-item PROM measuring patient health status in the weeks following lower limb arthroplasty, and has four domains: Pain, Fatigue/Sleep, Nausea/Feeling unwell, and Improving function/Mobility [16]. Secondly, the Oxford Arthroplasty Early Change Score (OACS) a 14-item measure to assess change during the first six weeks following surgery [16]. These scores can be used simultaneously but are independently interpreted.

This study aims to quantitatively assess differences in early postoperative recovery between patients with a UKA and TKA, between postoperative Day 1 and Week 6 (Day 42) using the OARS and OACS scores. The SF-36v2 Acute questionnaire will also be used (from postoperative Day 7) to assess the validity of the findings of these new scores.

Materials and Methods

Two consecutive cohorts of 37 UKA and 33 TKA patients were recruited from an NHS tertiary care centre in the United Kingdom. All procedures were performed using similar surgical technique and implants by the same group of ten surgeons. All patients received similar anaesthetic and intraoperative medications and were placed on the same post-operative care pathway. For the purposes of this study, the early recovery period is considered as the time of surgery through to approximately six weeks postoperatively [7].

Post-operatively, patients completed 3 questionnaires: the Oxford Arthroplasty Early Recovery Score (OARS), Oxford Arthroplasty Early Change Score (OACS), and the Short Form-36 version 2 Acute (SF-36v2).

The OARS and OACS scores were generated from questionnaires which were administered during the participants' early recovery period: postoperative days 1, 2, 3, 7, 14, and 42. OARS consists of 14 questions assessing elements of recovery (each scoring 4 'Strongly Disagree' to 0 'Strongly Agree'). Raw scores were then processed to provide an overall score, and four domain scores: Pain, Fatigue/Sleep, Nausea/Feeling unwell, and Improving function/Mobility. All scores range from 0-100, where higher is better. The OACS consists of 14 questions comparing present knee function to before the operation (each scoring -2 'Much Worse' to 2 'Much Better'). Raw scores were then processed to provide an overall score from -50 to 50 (higher is better), where 0 indicates preoperative patient-reported knee function.

The SF-36v2 Acute is a widely used and previously validated health measure covering both physical and mental health [17]. It has been used in various forms during the validation of other disease-specific health measures across a wide range of conditions [17-19]. It was completed by patients at the end of postoperative days 7, 14, and 42. It consists of 36 questions, each scored from 1 to 5. Recommended scoring algorithms were utilised for the SF-36v2 Acute (Quality Metric Health Outcomes™ Scoring Software 5.0; 2016). Questions assessed 8 domains of health: vitality, physical functioning, bodily pain, general health, physical role, emotional role, social functioning, and mental health. Each domain is scored from 0-100, where higher is better. The SF-36v2 Acute has a recall period of one week [20] and therefore makes it appropriate for use alongside the OARS and OACS on days 7, 14, and 42 but not days 1, 2, and 3. Comparison and correlation of the new OARS and OACS scores with previously hypothesised dimensions of the SF-36v2 will be used to assess construct validity. Particular OARS domains can be expected to demonstrate similar trends to closely related SF-36v2 Acute scores (Table 1).

Table 1: OARS Domains and most closely related SF-36v2 Acute domains.

70 patients were included in this study, some patients did not complete all time points for the study (n=33). Three of the incomplete cases are known to be due to medical conditions or complications postoperatively. However, a number of questionnaires and return envelopes were not received at the research office due to a problem occurring in the post office. Therefore, the true response rate may be higher than estimated, as patients reported returning their forms and would call the research office multiple times to confirm receipt (n=27).

The outcome scores for the UKA and TKA were then calculated and statistically analysed to assess if differences were found.

This study received ethical approval from the Health Research Authority North West - Liverpool East Research Ethics Committee (Reference 16/NW/0236),

Statistics

For incomplete datasets, scores were not imputed for participants following best practices when using/assessing measurement properties of a new instrument [21].

A p-value of <0.05 was used to identify statistical significance for all tests. Data was analysed and visualised using GraphPad Prism (Version 8.3.0 – © 1992-2019 GraphPad Software LLC.) and Microsoft

Excel with the Real Statistics Resource Pack (Release 5.4) Zaiontz C. (2018). Shapiro-Wilk test was used to determine if data was parametric.

For comparisons between cohorts at single time points, Student's t-test was used if data was parametric, and Mann-Whitney U test was used if data was non-parametric.

For comparisons between cohorts across test period (Day 1 to Day 42), data from each cohort was fitted using semilogarithmic least-squares regression curves, and an extra sum-of-squares F test was performed to assess the null hypothesis that one curve fits all data sets. The regression method was chosen as it was assumed that rate of change of scores will fall exponentially with days following surgery.

Results

Demographics

A total of 70 participants were included in the study, of whom 47% underwent a TKA and 53% underwent a UKA (Table 2).

Table 2: Unicompartmental versus Total Knee Participant Characteristics

Oxford Arthroplasty Early Recovery Score (OARS) Results

In both TKA and UKA cohorts, OARS increased from Day 1 to Day 42 (UKA 36.8 to 72.0, TKA 29.3 to 63.7). OARS was significantly greater in UKA cohort compared to TKA cohort at Day 7, 14, and in an overall comparison (**Fig 1**).

Figure 1: UKA vs TKA: OARS Overall

Oxford Arthroplasty Early Change Score (OACS) Results

In both TKA and UKA cohorts, OACS increased from Day 1 to Day 42. OACS=0 indicates preoperative functional status. At Day 42, mean OACS for the UKA cohort was 6.55 (95%CI -0.4 to 13.5) and for TKA cohort was 1.88 (95%CI -9.33 to 13.1), indicating more patients achieved preoperative functional status in UKA cohort. The overall OACS values and trend between UKA and TKA cohorts was not significantly different (**Fig 2**).

Figure 2: UKA vs TKA: OACS Overall

Oxford Arthroplasty Early Recovery Score (OARS) Domain Sub-score Results

Pain was mostly similar between UKA and TKA cohorts, however on Day 14 UKA had significantly less pain than TKA (UKA 30.3 vs TKA 32.4) (**Fig 3a**). Nausea/Feeling unwell was significantly better in UKA cohort and appears to stem mainly from the later recovery period – Days 7, 14, and 42 after surgery (71.3 vs 60.5, 78.4 vs 64.3, 86.7 vs 77.2 respectively) (**Fig 3b**). Fatigue/Sleep is significantly better in the UKA cohort, and this difference does not appear to be influenced by time; it is significantly different on Day 14 (54.2 vs 39.0) (**Fig 3c**). Improving function/Mobility is significantly better in the UKA cohort as well; this difference appears to be greatest immediately after surgery (Day 1, 42.2 vs 25.0) and declines thereafter (**Fig 3d**).

Figure 3: OARS Domain Subscore results

SF-36v2 Acute Results

SF-36 data was collected from patients on Days 7, 14, and 42. The questionnaire (SF-36v2 Acute) has recall period of 1 week, rendering it inappropriate for the earlier timepoints used in OARS/OACS analysis – Days 1, 2, and 3. All comparisons were made in a similar manner to OARS/OACS scores (Fig 1,2,3).

UKA was significantly better than TKA in Role-Emotional (Fig 4f), at all time points (Day 14 63.6 vs 42.7, Day 42 79.7 vs 56.8), as well as in General Health (Fig 4c), appearing to stem mainly from a difference in Day 42 (72.2 vs 61.5), and in Mental Health (Fig 4g), with the largest most significant difference at Day 1 (69.9 vs 59.0).

Physical Functioning (Fig 4a), Role-Physical (Fig 4b), and Bodily Pain (Fig 4h) rose similarly from Day 7 to 42, with no significant differences between UKA and TKA cohorts. Vitality (Fig 4d) followed a similar trend but with a smaller increase. Social Functioning (Fig 4e) increased in both groups from Day 7 to Day 42 – while the increase in TKA appears to be lesser than that of UKA, this was within error margins.

The OARS domains and related SF-36 domains (Table 2) followed similar trends. For these domains the scores of both UKA and TKA both progressively improve with time. Furthermore, for these domains UKA tend to have better scores than TKA. However, OARS appears to more sensitive in discerning differences between UKA and TKA (Fig 3) than the SF-36 as differences were statistically significant in all four of the OARS domains whereas they were only significant in one of the four of the associated SF-36 domains.

Figure 4: SF-36v2 Acute Results

Discussion

Two new scores, the OARS and the OACS, designed and validated for the assessment of early recovery following arthroplasty [16]), were used to compare recovery following TKA and UKA. For both scores, at all timepoints, patients in the UKA cohort report significantly higher scores, or scores that were not significantly different to the TKA cohort, providing direct evidence that the recovery following UKA is better and faster than recovery following TKA. Supporting evidence for the faster recovery of UKA than TKA, based on time to discharge from hospital, is widely available [22-25]. In this study, the average inpatient stay for UKA was 0.5 days reflecting the fact that most UKA were treated as day cases, whereas the average inpatient stay for TKA was 3.9 days.

The OARS showed that early recovery following knee arthroplasty tended to follow a logarithmic curve, with the speed of recovery being rapid early on, then progressively decreases. Following a logarithmic transformation of the time axis, there was a linear relationship for the overall OARS score between recovery and time, and the graphs of TKA and UKA were significantly different and approximately parallel. This suggests that, at least up to two months post operatively, not only had UKA recovered more at every timepoint than TKA, but also that TKA took two to three times longer to reach the equivalent stage of recovery as UKA. This is perhaps not surprising as UKA is a generally smaller procedure than TKA, involving a smaller incision, reduced soft tissue manipulation, smaller cuts to bone, less damage to the medullary canals and smaller implants with less or no bone cement [17, 18].

Differences between TKA and UKA varied for the different OARS sub-scores and were influenced by the time of follow up. During the first week there was no difference in the level of pain following UKA and TKA. This is likely due to identical pain control regimens in the first week, consisting of both regular and top-up medication, controlling the pain equally well for UKA and TKA, despite UKA being less invasive. After the first week, there appeared to be less pain following UKA than TKA. It is likely that this is because less medication was used in later weeks, thereby not masking the effect of differing invasiveness between the procedures. In contrast, with Improving function/Mobility, although UKA performed better overall, the difference was most marked the first day, when the limited invasiveness of UKA allows for accelerated early mobilisation.

The sub-scores relating to Nausea/Feeling unwell and Fatigue/Sleep had the same pattern with progressive improvement with time, and UKA tending to be better at all time points. However, the biggest differences occurred later in the recovery period. These scores assess the more systemic effects of the operation. In the early postoperative period, anaesthetic and analgesic medication, which are required by both UKA and TKA tend to cause nausea and poor sleep, so the differences between the UKA and TKA cohorts are small. In the later study period, when the peri-operative medication has less effect, the differences become more marked. As an interventional procedure, arthroplasty results in release of postoperative inflammatory markers [16] which contribute to feelings of nausea, feeling unwell and fatigue, and the more invasive TKA will have a greater effect than the smaller UKA.

The OACS was designed to compare a patient's status after an intervention with their status before the intervention. Immediately after the operation, the patients were substantially worse than pre-operatively. With time the patients progressively improved. It took until the end of the study (at six weeks) for the patients to recover until they reported the same status as they did pre-operatively. We found no significant difference in OACS scores following UKA and TKA at any time point. This is possibly because during this early recovery period, patients tended to be worse than they were pre-operatively. For patients who felt worse whilst answering the OACS questionnaire, only two options were relevant: 'much worse' or 'worse' [16]. In contrast, all five options for each question in the OARS (from 'strongly disagree' to 'strongly agree' [16]) would have remained relevant. Therefore, the OACS score may not be as useful as the OARS for the early recovery period where patients feel worse than pre-operatively. Instead, the OACS might be more useful for assessing a longer recovery period, when an intervention would be expected to make a more substantial improvement. Further assessment of this is needed.

The SF-36 could only be used after the first week [20]. Like the OARS the SF-36 scores for both UKA and TKA tended to improve with time, with faster improvement early on. In general, UKA tended to have better SF-36 scores than TKA and when differences were statistically significant, they all favoured UKA. Statistically significant differences favouring UKA were seen in General Health, Mental Health, and Role-emotional subscales. Interestingly, a very large difference was seen in the Role-emotional subscale. Taken together this suggests that UKA patients, compared to TKA patients, felt during their recovery that their general health and mental health were better. As a result they had much less emotional restriction in their everyday activities [26]. Overall, the trends seen in the OARS subscales were similar to those seen with comparable SF-36 subscales (Table 2). This supports the validity of the OARS instrument's domain scoring system.

Limitations

This is a single centre study so the results may have limited generalisability. As the UKA recover quicker than TKA they are routinely sent home the same day. The results in the first few days may be influenced by the fact that most UKA were at home whereas most TKA where in hospital during this period. Lack of preoperative data is a limitation of this study. The scores were designed to be used post operatively so were not used preoperatively. Groups were not compared for equivalence in terms of BMI, use of opioids and co-morbidities, so differing preoperative characteristics between the two cohorts may therefore potentially confound the results. However, patients needing UKA or TKA have only slightly different symptoms. These pre-operative differences would not have been expected in domains where the post-operative differences were marked such as nausea/Feeling unwell, and fatigue/ sleep. So, it is unlikely that pre-operative differences would have affected the post-operative recovery scores. It was noted that an older cohort of patients presented for TKA and this could be of relevance. Finally, as newly developed scores were used, no minimum clinically important differences (MCID) values were available, and so important differences were identified statistically. Therefore, we do not how clinically important the statistically significant differences where.

Conclusion

Patients undergoing both TKA and UKA initially recover rapidly and the recovery then progressively slows over the first 6 weeks. Recovery was significantly better and faster following UKA than TKA. To reach any stage of recovery took two to three times longer for TKA compared to UKA. These differences appear to stem primarily from improved function early in recovery, and with reduced of

nausea and feeling unwell and improved sleep later in the recovery. The difference is likely to be a result of UKA being a smaller procedure with less damage to the bone and surrounding soft tissue.

The OARS proves to be a useful instrument in the assessment of the early postoperative period, which is poorly understood in literature. It also appears to be useful comparing interventions that might improve recovery. The score provides a multi-dimensional view of the recovery process, measuring clinically relevant factors that are easily assessed by patients.

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