Longer hospital stay, more complications, and increased mortality but substantially improved function after knee replacement in older patients

A study of 3,144 primary unilateral total knee replacements

Julian F MAEMPEL[1], Fraser RIDDOCH[2], Neville CALLEJA[3], and Ivan J BRENKEL[1]

[1] Department of Trauma and Orthopaedics, Victoria Hospital, Kirkcaldy, Fife; [2] University of Edinburgh Medical School, Edinburgh, Midlothian, UK; [3] Consultant in Public Health and Director, Directorate of Health Information and Research, Pieta, Malta.
Correspondence: julian.maempel@nhs.net
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Background and purpose — Total knee replacement (TKR) is being increasingly performed in elderly patients, yet there is little information on specific requirements and complication rates encountered by this group. We assessed whether elderly patients undergoing TKR had different length of stay, requirements, complication rates, and functional outcomes compared to younger counterparts.

Patients and methods — We analyzed prospectively gathered data on 3,144 consecutive primary TKRs (in 2,092 patients aged less than 75 years, 694 patients aged between 75 and 80 years, and 358 patients aged over 80 years at the time of surgery).

Results — Incidence of blood transfusion, urinary catheterization, postoperative confusion, cardiac arrhythmia, and 1-year mortality increased with age, even after adjusting for confounding factors, whereas the incidences of chest infection and mortality at 1 month were highest in those aged 75–80. Rates of thromboembolism, prosthetic infection, and revision were similar in the 3 age groups. All groups showed similar substantial improvements in American Knee Society (AKS) knee scores, which were maintained at 5 years. Older patients had smaller improvements in AKS function score, which deteriorated between 3 and 5 years postoperatively, in contrast to the younger group.

Interpretation — Elderly people stand to gain considerably from TKR, particularly in terms of pain relief, and they should not be denied surgery based solely on age. However, they should be warned that they can expect a longer length of stay, a higher requirement for blood transfusion and/or urinary catheterization, and more medical complications postoperatively. Mortality was also higher in the older age groups. The risks have been quantified to assist in perioperative counselling, informed consent, and healthcare planning.

Healthcare systems and medical professionals will need to cater for increasing numbers of total knee replacements (TKRs) in elderly people in the coming years (Carr et al. 2012), but little is known about inpatient requirements and the postoperative complications suffered by this particular patient group. Some studies have shown good joint-specific pain relief and functional benefits from TKR in the elderly (Anderson et al. 1996, Birdsall et al. 1999), although it has been suggested that elderly patients may attain lower global function than their younger counterparts (Clement et al. 2011, Kennedy et al. 2013). However, studies attempting to describe complications in the elderly undergoing TKR have been small (Zicat et al. 1993, Hosick et al. 1994, Joshi et al. 2003), have lacked comparator groups (Hosick et al. 1994, Joshi et al. 2003), or have failed to quantify the time scales within which complications have occurred (Clement et al. 2011, Kennedy et al. 2013). Other studies and registries have been based on discharge summary databases without specific patient follow-up (Kreder et al. 2005, Mahomed et al. 2005, Scottish Arthroplasty Project, 2012). They therefore relied on third-party coding of discharge summaries and reported only on mortality during the index admission (Kreder et al. 2005) or selected complications requiring hospital re-admission within 30 or 90 days (Kreder et al. 2005, Mahomed et al. 2005, Scottish Arthroplasty Project, 2012).

The aim of this study was to determine whether elderly patients undergoing TKR had different postoperative length of stay, inpatient requirements (i.e. blood transfusion and urinary catheterization), complication rates, and mortality rates to those of their younger counterparts. Functional outcomes were assessed as a secondary outcome measure, to determine whether elderly patients gained benefit comparable to that of their younger counterparts, independently of recorded admission requirements and complications.

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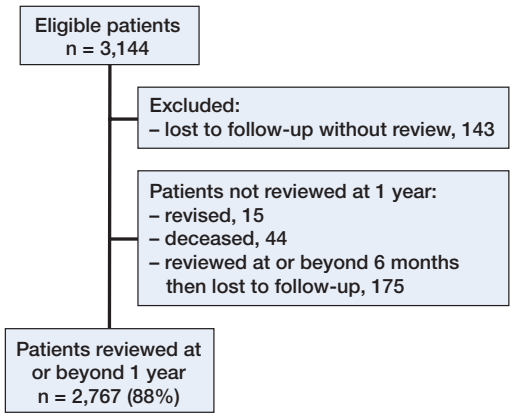

Figure 1. Patients included in the study.

Table 1. Percent complications in each age group (unadjusted)

	Group 1	Group 2	Group 3	Overall
Blood transfusion	6.6	11	17	8.8
Urinary catheterization	18	28	50	22
Acute confusion (admission)	0.6	2.2	3.1	1.2
Cardiac arrhythmia (admission)	0.4	1.0	2.2	0.8
LRTI (1 month)	0.9	2.3	1.6	1.3
ACS (1 month)	0.4	1.1	0.6	0.5
DVT/PE (1 month)	1.0	0.6	0.9	0.9
Deep infection (1 year)	1.1	2.0	1.7	1.4
Revision (1 year)	0.5	0.7	0.3	0.5
MUA (1 year)	1.8	0.3	0	1.3

LRTI: lower respiratory tract infection;
ACS: acute coronary syndrome;
DVT/PE: deep-vein thrombosis/pulmonary embolism;
MUA: manipulation under anesthetic.

Patients and methods

Patients undergoing unilateral primary cemented DePuy Sigma TKR (DePuy, Warsaw, IN) at Fife Acute Hospitals Trust between October 1998 and February 2012 were reviewed pre- and postoperatively (at 12–18 months and then at 3 and 5 years) in a dedicated arthroplasty review clinic. Length of stay, requirements (blood transfusion and urinary catheterization), and complications during admission were recorded. At review, the patients were examined clinically to enable calculation of their American Knee Society knee joint-specific score (AKSK) and functional score (AKSF) (Insall et al. 1989), and any complications encountered were documented. Additional written medical records were analyzed where appropriate. Functional scoring was undertaken by experienced arthroplasty nurses, and the data were entered into a prospectively maintained database. All patients who underwent primary TKR were included in this study, except patients who underwent simultaneous bilateral TKR (n = 199) or simultaneous hip and knee arthroplasty (n = 1). 3,144 consecutive TKRs were included and 2,767 patients (88%) were reviewed at or beyond 1 year (Figure 1). Any patients who were not followed up but who were known to have suffered a complication within the specified time frame were included in analyses pertaining to that event.

3 years postoperatively, 1,648 patients (73%) (1,144 aged less than 75; 364 aged 75–80 years, and 140 aged over 80 years) out of a group of 2,245 patients who underwent surgery up to July 2009 were reviewed clinically for AKSK scoring, while 1,686 patients (75%) underwent AKSF scoring (38 patients were AKSF scored over the telephone). 5 years postoperatively, 1,145 patients (64%) (831 aged less than 75, 243 aged 75–80, and 71 aged over 80) out of a group of 1,784 patients who underwent surgery before January 2008 were reviewed clinically for AKSK scoring, while 1,196 (67%) underwent AKSF scoring.

Statistics

Statistical analysis was undertaken using SPSS version 20. The patients were divided into 3 groups based on their age at the time of surgery (group 1 aged < 75 years, group 2 aged 75–80 years, and group 3 aged > 80 years). The nature of distribution of continuous variables was determined using Shapiro-Wilk testing. Given the large numbers of subjects and the potential for bias by erroneous rejection of the null hypothesis using Shapiro-Wilk testing in isolation in large samples, Q-Q plots were used to verify these findings. Repeat measurements in individuals were considered to be related observations and appropriate statistical tests were used (see below). Independent, continuous normally distributed data were compared between groups using ANOVA, while non-normally distributed data were compared using Kruskal-Wallis test if unrelated or related-samples Wilcoxon signed rank test if paired. Analysis of nominal datasets was undertaken using chi-square tests. The independent effect of age grouping (as defined above) on complications and mortality was confirmed by adjusting for other potential determinants of complications and mortality. Statistically significant parameters were only included in binary logistic regression models if clinically relevant, and if they were believed not to link age with the outcome variable in question, to avoid introducing additional bias. Any p-value of < 0.05 was considered statistically significant.

Results

There were 1,442 men and 1,702 women. 2,092 patients were aged less than 75 years (group 1, median 66 (28–74) years) while 694 patients were aged between 75 and 80 (group 2, median 77 (75–80) years) and 358 were aged 81 or more (group 3, median 83 (81–98) years). The overall incidence of events is given in Table 1.

Table 2. Mean hemoglobin concentration (SD) in the 3 groups

Hb, g/dL	Group 1	Group 2	Group 3	p-value[a]
Preop.	13.8 (1.4)	13.4 (1.4)	13.0 (1.4)	< 0.001
Postop.	11.6 (1.5)	11.1 (1.4)	10.7 (1.5)	< 0.001
Change	–2.2 (0.99)	–2.3 (0.98)	–2.3 (1.2)	0.2

[a] ANOVA.

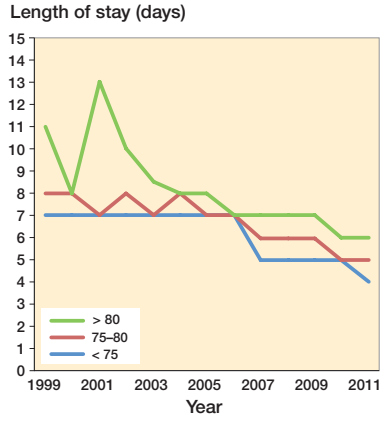

Figure 2. Median length of stay throughout the study period. This was higher in the elderly (p < 0.001) but all 3 groups showed a reduction in median length of stay over the study period.

There was no statistically significant difference in the drop in hemoglobin concentration (Hb) between the preoperative measurement and the 1-day postoperative measurement with increasing age (p = 0.2), but both preoperative Hb and postoperative Hb were lower in the elderly (p < 0.001) (Table 2). Patient distribution regarding gender and ASA grades was not equal between the groups (p < 0.001 in both cases), with the older groups having higher ASA grades and a greater proportion of women.

Length of hospital stay

Median length of stay was longer in the older age groups (p < 0.001, independent-samples Kruskal-Wallis test) and all 3 groups showed a significant reduction (of almost 50%) in median length of stay over the period under study (Figure 2).

Table 4. Orthopedic complications occurring within 1 year of surgery. Group 1 was used as the reference group

	Odds ratio (95% CI) Group 2	Group 3	p-value
Deep infection	1.8 (0.9–3.6)	1.5 (0.6–4.1)	0.3
Revision	1.4 (0.4–4.4)	0.7 (0.1–5.6)	0.8
MUA	0.2 (0.04–0.77)	N/A	0.02 [a]

[a] 2 × 2 chi-squared test for patients in groups 1 and 2.

Data regarding requirements and complications during the index admission were available for all patients, except with regard to urinary catheterization, where these data were not recorded for the first 167 patients. More men (28%) than women (17%) required catheterization (adjusted OR = 2.1, 95% CI: 1.7–2.5; p < 0.001), but the effect of age was independent of gender (Table 3).

Medical complications within 1 month of surgery

Data were collected on clinical thromboembolic events confirmed by imaging studies, acute coronary syndrome (ACS, including unstable angina), and lower respiratory tract infections (LRTIs) occurring within 1 month of TKR. Age appeared to be related to incidence of LRTI initially (p = 0.01), but after adjusting for ASA grade, this association was only found to be statistically significant for group 1 (reference) and group 2 (OR = 2.4, 95% CI: 1.1–4.9) but not for group 3 (OR = 0.4, 95% CI 0.55–4.3). There was no statistically significant relationship between age and ACS (p = 0.1) or thromboembolic disease (p = 0.7).

Orthopedic complications within 1 year of surgery

There was no statistically significant difference in incidence of deep infection or all-cause revision at 1 year postoperatively in the different age groups, and age was the only variable with a statistically significant relationship to manipulation under anesthetic (MUA). As none of the patients aged over 80 underwent MUA, odds ratios could only be calculated for group 2 relative to group 1 (Table 4).

Table 3. Adjusted odds ratios and p-values after binary logistic regression, for blood transfusion, urinary catheterization requirements, and incidence of early postoperative complications, according to age. Group 1 was used as the reference group

	Adjusted Odds ratio (95% CI) Group 2	Group 3	p-value	Co-variates adjusted for
Blood transfusion	1.4 (0.99–1.9)	1.8 (1.3–2.6)	0.004	Preop. Hb., ASA
Urinary catheterization	1.8 (1.5–2.3)	2.4 (1.8–3.1)	< 0.001	Sex, ASA
Acute confusion	3.3 (1.5–7.2)	4.3 (1.9–9.8)	0.001	ASA
Cardiac arrhythmia	3.4 (1.6–7.2)	4.6 (2.0–10.6)	< 0.001	Preop. Hb

Table 5. Preoperative American Knee Society knee score (AKSK), preoperative American Knee Society function score (AKSF), and postoperative AKSK and AKSF scores at 12–18 months

	AKSK		AKSF	
	preop. [a]	12–18 month [b]	preop. [b]	12–18 month [b]
Group 1	37 (15)	92 (2–100)	65 (0–100)	80 (0–100)
Group 2	36 (16)	93 (25–100)	60 (10–100)	80 (0–100)
Group 3	36 (17)	93 (35–100)	55 (0–90)	65 (0–100)
p-value	0.7 [c]	0.001 [d]	< 0.001 [d]	< 0.001 [d]

[a] mean (SD), [b] median (range), [c] ANOVA, [d] Kruskal-Wallis test.

Postoperative mortality

Mortality rates at 1 month were 0.15% in group 1, 1.0% in group 2, and 0.86% in group 3. Odds ratios, adjusted for ASA were 6.1 (95% CI: 2–24) for group 2 and 3.0 (0.5–19) for group 3, relative to group 1. Overall mortality at 1 year was 1.5%, but it was 2.0% in group 2 and 3.2% in group 3, in comparison to 1.0% in group 1. Odds ratios for mortality at 1 year, adjusted for ASA, were 2.2 (1.0–4.5) for group 2 and 3.0 (1.3–6.8) for group 3, relative to group 1. The differences in mortality rates at 1 month ($p = 0.03$) and 1 year ($p = 0.02$) were statistically significant after correction for ASA grade.

Functional scores

All groups showed clinically and statistically significant improvements in AKSK and AKSF between measurement preoperatively and measurement 12–18 months postoperatively (all $p < 0.001$, related-samples Wilcoxon signed rank test) (Table 5). Furthermore, all groups had clinically and statistically significant improvement (all $p < 0.001$, related-samples Wilcoxon signed rank test) in the pain component of the AKS clinical score (median +40 points in all groups, range −20 to +50 in groups 2 and 3 and −30 to +50 in group 1) and the magnitude of improvement between groups was similar ($p = 0.2$). At 3 years postoperatively, median AKSK was 93 (17–100) in group 1, 93 (30–100) in group 2, and 92 (37–99) in group 3 ($p = 0.2$), while the median AKSF was 80 (0–100) in group 1, 70 (0–100) in group 2, and 60 (0–100) in group 3 ($p < 0.001$). 5 years postoperatively, median AKSK score was 93 in group 1 (23–100), 94 (30–100) in group 2, and 94 (44–100) in group 3 ($p = 0.01$), while the median AKSF was 80 (0–100) in group 1, 60 (0–100) in group 2, and 55 (0–100) in group 3 ($p < 0.001$).

Discussion

Older patients undergoing TKR can expect a longer hospital stay, higher requirement for blood transfusion and/or urinary catheterization, and higher rates of medical complications and mortality after TKR than their younger counterparts. However, they can also expect clinically significant improvements in pain and joint function, similar to those experienced by younger patients. Overall functional status was also substantially improved at 1 year, although to a lesser extent than in their younger counterparts. Improvements in joint-specific function were maintained in the medium term, while improvements in global function deteriorated with time, in contrast to the younger patient group.

With the advent of more accessible information, mostly through the internet, many patients ask detailed questions about proposed treatments and risks. Patient expectations correlate with postoperative outcome and satisfaction (Scott et al. 2010, 2012, Clement et al. 2014). Surgeons must therefore explain and quantify the potential benefits and risks of TKR, to aid the patient in setting realistic expectations. There has been little research on specific perioperative requirements and complication rates in elderly patients undergoing TKR. The Scottish Arthroplasty Project (SAP) reports on selected complications that occur within 30 days of surgery, while other registries do not. One possible source of bias in the SAP and other retrospective discharge summary-based studies (Mantilla et al. 2002, Kreder et al. 2005, Mahomed et al. 2005, SooHoo et al. 2006) is only inclusion of complications requiring hospital re-admission. Furthermore, these studies depend on discharge summary coding by non-medical personnel rather than true patient follow-up, and assume that those lost to follow-up have not developed complications. While some make brief references to age being a risk factor for certain complications (Mantilla et al. 2002, SooHoo et al. 2006), most do not provide specific information relating to the risks encountered by elderly patients undergoing TKR. Our study design was different. We used data from specific patient review and we attempted to account for all patients, giving clear indications of the number of individuals who were lost to follow-up.

We confirmed previously described correlations between age and length of stay (Forrest et al. 1998, Kreder et al. 2005, Clement et al. 2011). Frailty and lower muscle bulk may contribute to slower progression with physiotherapy, but we also suggest that the elderly are more prone to early postoperative complications (e.g. acute confusion) and interventions (blood transfusion and urinary catheterization), which could delay discharge.

Elderly patients are at increased risk of postoperative delirium (Marcantonio et al. 1994), and this has been confirmed in the context of TKR, where smaller studies have found trends that have failed to reach statistical significance (Clement et al. 2011). The incidence of complications, while commoner in the over-75 age groups, did not uniformly increase with age for all complications in the older subgroups. 1 month postoperatively, mortality was, as expected, lowest in the youngest group (group 1), but—unexpectedly—it was highest in group 2, and surgeons should not underestimate the risks to patients

who are considered to be at the younger end of the "elderly" spectrum. This may be in part due to increased vigilance when selecting very old (group-3) patients for surgery compared to those in the 75- to 80-year age group, who (in the absence of any evidence to confirm such a perception) may sometimes be wrongly assumed by surgeons to be more able to cope with surgical stresses. We suggest that surgeons should be aware of increased risks when operating on all older patients, and not just the very elderly. Other interventions (catheterization and blood transfusion) and complications (confusion, cardiac arrhythmia, and 1-year mortality) were not only less common in the youngest group; their incidence continued to rise with increasing age over 75 years.

The observed increased complication and mortality rates in the elderly may relate to a reduced physiological reserve in this group—a concept illustrated by increased transfusion rates in the elderly, despite a similar drop in hemoglobin. This may be attributable to a lower preoperative hemoglobin in the elderly group, making them less able than their younger counterparts to cope with similar levels of blood loss.

Only reporting total complication rates in different age groups is an oversimplification, since other factors can affect the risk of a particular complication. Thus, we have reported adjusted odds ratios for complications affected by increasing age, taking account of other clinically relevant variables.

Age is a risk factor for cardiac arrhythmia in general (Benjamin et al. 1994) and cardiac arrhythmia after thoracic surgery (Amar et al. 2002), and we can confirm that there is a similar relationship after TKR. Lower respiratory tract infections were commoner in group 2, but the incidence was similar in groups 1 and 3. The higher mortality in the elderly is not unexpected, although it has been suggested that arthroplasty patients have lower mortality than age-matched controls in the general population, possibly due to pre-selection of generally fit patients for arthroplasty (Mahomed et al. 2005).

Carr et al. (2012) reported that 80% of deep joint infections are apparent within the first year; hence our decision to report on these at this time point. No increased risk of deep infection or all-cause revision was observed in the elderly, and in agreement with a study by Mahomed et al. (2005), elderly patients underwent manipulation under anesthetic less frequently. Thromboembolism and joint infection are 2 of the most feared complications of TKR, but they were not observed more frequently in the elderly.

The AKSK relates solely to the replaced joint. Elderly patients showed clinically significant improvements in pain and AKSK scores, comparable to those experienced by their younger counterparts. Pain relief is a more important predictor of satisfaction after TKR than functional ability (Baker et al. 2007), and ongoing pain is reportedly the strongest predictor of dissatisfaction after TKR (Scott et al. 2010). Elderly people therefore stand to gain considerably from TKR. Improvements in knee-specific scores were maintained with time. The AKS clinical rating system recognizes that patients' global functional status may be affected for reasons unrelated to the knee joint in question (e.g. other joint pathology or general frailty), hence the dual scoring system (Insall et al. 1989, Konig et al. 1997). The AKSF is influenced by factors other than the status of the replaced knee joint. As the incidence of osteoarthritis in other joints (Arden and Nevitt, 2006), comorbidities, and general frailty increase with age, it is not surprising that the older group had lower median AKSF scores pre- and postoperatively. All 3 groups, however, showed substantial improvements in AKSF after TKR. While this improvement was maintained in the younger group at 5 years, older patients experienced a gradual decline.

We acknowledge that our study had limitations, mainly the loss of some patients to follow-up. As would be expected, loss to follow-up was more pronounced at longer follow-up time points, but reporting of functional scores in the medium term was a secondary outcome measure in this study, whereas data pertaining to the index admission were available for all patients, and approximately 95% and 90% of patients were accounted for at 6 and 12 months, respectively. This facilitated quantification of the risk of various complications occurring after TKR, the primary outcome measures of this study. Where necessary, additional information was obtained from hospital records and general practitioner records. The strengths of the present study include the large patient numbers, specific patient review for data collection, and reporting of adjusted odds ratios.

Further studies should focus on analysis of the underlying reasons for increased complication rates in the elderly, so that any modifiable risk factors associated with increasing age can be optimized preoperatively. The development and validation of scoring systems to predict risk of complications using the variables identified is another interesting prospect for further study. Quantification of the additional risks and expected functional improvements facilitates better patient counselling by surgeons and more informed decision making by patients. It is also important for healthcare planners, who must plan and ration resources to accommodate increasing numbers of operations on the elderly in the coming years.

JM and FR were responsible for conversion of raw data into a format appropriate for statistical analysis, and for literature review and initial drafting of the manuscript. Statistical analysis was performed by JM and NC. IB was responsible for design of the database and setting up of review clinics for data collection, and also for the initial idea for this study. He provided guidance on drafting of the manuscript and subsequent improvements.

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No competing interest declared.

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