Primary arthroplasty may be denied to very elderly patients based upon the perceived outcome and risks associated with surgery. This prospective study compared the outcome, complications, and mortality of total hip (TKR) and total knee replacement (THR) in a prospectively selected group of patients aged ≥ 80 years with that of a control group aged between 65 and 74 years. There were 171 and 495 THRs and 185 and 492 TKRs performed in the older and control groups, respectively. No significant difference was observed in the mean improvement of Oxford hip and knee scores between the groups at 12 months (0.98, (95% confidence interval (CI) -0.66 to 2.95), p = 0.34 and 1.15 (95% CI -0.65 to 2.94), p = 0.16, respectively). The control group had a significantly (p = 0.02 and p = 0.04, respectively) greater improvement in the physical well being component of their SF-12 score, but the older group was more satisfied with their THR (p = 0.047). The older group had a longer hospital stay for both THR (5.9 versus 9.0 days, p < 0.0001) and TKR (6.2 versus 8.3 days, p < 0.0001). The rates of post-operative complications and mortality were increased in the older group.

During the next decade it is predicted that within western society there will be a marked increase in the elderly population, where currently the fastest growing group is the “oldest old” (> 85 years). The Scottish population over the age of 75 years is projected to increase by 81% by the year 2031. The rate of total hip replacement (THR) and total knee replacement (TKR) has been steadily increasing during the last two decades. However, the mean age of these patients has not changed during this period in the face of an aging population, which may reflect the increased rate of arthroplasty in younger patients, hence counteracting the effect of the older population. An alternative explanation could be that patients older than 85 years are less likely to be offered joint replacement surgery than their younger counterparts, despite being equally willing to undergo surgery. If there is a reluctance to perform THR and TKR in older patients this may not be directly related to age, but to concern over associated comorbidity and potential post-operative complications.

Small retrospective studies of THR and TKR in patients over the age of 80 report significant pain relief and improved functional outcomes, at a cost of increased rates of post-operative complications and mortality. Comparative studies have also shown that patients aged 80 years or more experience relief of pain and improvement in function equal to their younger counterparts at follow-up of one year, and the rates of complications were not increased in older age groups.

This study aims to answer whether patients ≥ 80 years of age benefit from THR and TKR to the same extent as their younger counterparts, and if this benefit is at the risk of an increased rate of post-operative complications, including mortality. To address these questions we conducted a prospective study to compare pre-operative comorbidity, pain relief, functional outcome, satisfaction, health-related quality of life outcomes, post-operative complications, length of stay and mortality after THR and TKR in a group of patients aged ≥ 80 years with these parameters in a younger group of patients aged between 65 and 74 years.

Patients and Methods
During a consecutive thirty month period (March 2006 to August 2008) patients undergoing THR and TKR at the study centre had prospectively compiled outcome data recorded. Only patients with primary osteoarthritis and from within our catchment area were included, patients with inflammatory conditions were excluded. In the standard group (control) the age range was 65 to 74 years of age for both THR and TKR, being...
the mode age range for our unit (Fig. 1), with 376 patients (495 THR) and 435 patients (492 TKR) in this age range for each joint, respectively. These control groups were compared with the older group (≥ 80 years), which comprised 163 patients (171 THR) and 163 patients (185 TKR).

Comorbidity was recorded at pre-operative assessment, categories included were: heart disease, hypertension, lung disease, vascular disease, neurological problems, stomach ulcer, kidney disease, liver disease, anaemia, depression, back pain, and pain in other joints. Oxford hip or knee scores,17,18 and Short-Form 12 scores (SF-12)19 were recorded pre-operatively at six and 12 months post-operatively. Satisfaction was assessed at one year using eight questions (Table I) and each had a graded response using a visual analogue scale from 1 (most satisfied) to 6 (least satisfied).20,21 The total of this score ranges from 8, being most satisfied, to 48 being the least satisfied. Length of stay was recorded to nearest full day. Pre-operative American Society of Anesthesiologists (ASA) grade22 was obtained from the anaesthetic chart. The need for transfusion, occurrence of a post-operative medical complication (confusion, pneumonia, urinary tract infection, myocardial infarction, deep-vein thrombosis (DVT) with a positive Doppler scan), transfer to the high dependency unit, re-admission to hospital, and implant infection were also recorded.

The one year mortality rate was calculated for all patients, inclusive of those with and without completion of outcome measures at 12 months for both groups. Mortality figures were obtained from the General Register Office for Scotland. In total 25 patients died before one year follow-up.

During the study period the most commonly performed THR was the Exeter stem with a cemented polyethylene cup, and the cemented Kinemax TKR System. All patients were reviewed at a pre-assessment clinic. The majority were admitted on the day of their surgery unless medical or social circumstances prevented this. All patients were prescribed DVT prophylaxis in accordance with the Scottish Inter-collegiate Guidelines Network.23 A standardised rehabilitation protocol, with mobilisation on day one post-operatively was used. Time of discharge was a multi-disciplinary decision, in accordance with functional and medical status. Patients were reviewed at six weeks, six months and one year post-operatively. The study centre serves a catchment population of approximately 780 00024 and re-admission under any medical or surgical speciality was recorded from the electronic patient admission records.

A minimal clinically important difference, being the smallest change of the score to be of importance, has yet to be defined for both the Oxford hip and knee scores.25 Approximately half the standard deviation (SD) for a scoring measure is accepted as the minimal clinically important difference.26,27 Analysis of the dataset used, for all age groups, demonstrated a mean improvement in Oxford score of 19.5 (SD 9.8) for THR and of 15.8 (SD 9.5) for TKR. Thus, half of the SD was 5 for both THR and TKR scores. The same method was used to assign the minimal clinically important difference for the pain and physical components of the Oxford score, which was found to be 3 points. The minimal clinically important difference for the physical component of the SF-12 score was 5.4 for THR and 5.2 for TKR using the SD for the dataset analysed.

**Statistical analysis.** Non-parametric methods for analyses were used, as the distribution of the Oxford hip and knee scores were skewed. The Wilcoxon signed-rank test was used to compare pre- and post-operative scores and a Mann-Whitney U test was used to compare the control group with the older group. However, the absolute improvement of scores was normally distributed (skewness = 0.15) and an unpaired t-test was used to compare the two groups. Fisher’s exact test or a chi-squared test was used to compare dichotamous variables and Cox regression was used to analyse the mortality risk between the groups for THR and TKR. A one-way analysis of variance (ANOVA) test was performed to compare subgroups of the ≥ 80 years cohort according to two-yearly intervals (80 to 81, 82 to 83, 84 to 85, 86 to 88, and > 88) with the control group, to assess whether outcome measures varied within the study group.

Ethical approval was obtained for analysis and publication from the regional ethics committee (11/AL/0079).

**Results**

The mean age at operation of the THR control group was 70.3 years (65 to 74) and for the TKR group it was 70.7 years (65 to 74). The mean age of the ≥ 80 years group was 84.0 years (80 to 93) for THR and 83.3 years (80 to 92) for TKR. There was a significantly higher percentage of females in the ≥ 80 years group for both THR (55.2% versus 63.7%, p = 0.002) and TKR (55.1% versus 63.2%, p = 0.0001).
The median number of comorbidities was 2.0 for the control group and 2.1 for the ≥ 80 years group (p = 0.6). The mean ASA grade was 2.0 (1.0 to 3.0) in the control group and 2.4 (1.0 to 3.0) in the ≥ 80 years group (p = 0.03). Both cohorts that underwent TKR had fewer comorbidities (2.2 versus 2.6, p = 0.003, and 2.1 versus 2.7, p = 0.006, respectively) and a lower ASA grade (1.8 versus 2.4, p = 0.001, and 2.1 versus 2.8, p = 0.002, respectively) than those undergoing THR. Hypertension was the most common comorbidity in both groups, with 76% of patients suffering with hypertension in isolation or in combination with another comorbidity.

The post-operative Oxford scores at six and 12 months were significantly improved (Table II). No significant difference was identified between the two groups in the improvements for Oxford hip or knee scores. The 95% confidence intervals (CI) for the mean difference between the groups for improvement did not differ by more than the minimal clinically important difference (5) following either THR or TKR. Subgroup analysis of the pain (six of 12 questions) and functional (six of 12 questions) components of the Oxford hip and knee scores demonstrated no significant difference between the groups, except for functional improvement after THR, with the control group improving to a greater extent (Table III).

There were significant improvements for both groups in the physical component of the SF-12 score at 12 months for both THR and TKR (Table II). The control group had a significantly greater improvement in the physical component compared with the ≥ 80 years group for both THR and TKR (Table II) although, the mean difference did not exceed the minimal clinically important difference, but the 95% CI for the THR was greater than it. The mental component of the SF-12 improved in both groups following THR and TKR, but this did not reach statistical significance (p > 0.2) nor was there any significant difference between the cohorts for THR and TKR (Table II).

Overall, patients who received a THR were more satisfied than those who received a TKR (14.5 versus 17.4, p = 0.009). The ≥ 80 years group were more satisfied than the control group after THR (14.1 versus 15.6, respectively, SD 6.9, p = 0.047). There was, however, no significant
difference between the groups after TKR (19.0 versus 18.2, respectively, SD 8.1, p = 0.67).

The risk of transfusion, confusion, pneumonia, urinary tract infection, myocardial infarction, admission to a high dependency unit, re-admission, and infection of prosthesis was higher in the ≥ 80 years for both THR and TKR (Table IV). The risk of post-operative DVT was less in the ≥ 80 years group, than in the control group following both THR and TKR (Table IV).

The one year mortality rate for THR in the ≥ 80 years group was 3.7% (6 of 169) and 2.4% (9 of 385) for the control group (hazard ratio (HR) = 1.7, 95% CI 0.85 to 4.9, p = 0.37). The one year mortality rate for this group after TKR was 2.5% (4 of 163) and 1.4% (6 of 435) for the control group (HR 1.5, 95% CI 0.87 to 3.6, p = 0.3). After THR the ≥ 80 years group was at an increased risk of mortality relative to those receiving a TKR, but this was not significant (HR 1.6, 95% CI 0.9 to 3.5, p = 0.34).

The patients ≥ 80 years had a longer length of stay for both THR (9.0 days versus 5.9 days, p < 0.0001) and TKR (8.3 days versus 6.2 days, p < 0.0001) than the control group. Overall age correlated with length of stay (Pearson’s coefficient 0.21, p < 0.001).

Analysis of each age cohort within the ≥ 80 years group revealed no significant differences (p > 0.05, ANOVA) relative to the control group for comorbidity (number or ASA grade), outcome measures or complications (Fig. 2). There was a significant difference in the length of stay with patients older than 85 years of age needing five to six days longer stay after a TKR compared to those aged 80 to 85 years (p = 0.002), a difference which was not observed after a THR.

**Discussion**

This is the first prospective study to demonstrate that the outcome of THR and TKR in patients ≥ 80 years old is equal to that of their younger counterparts and that they are more satisfied with their THR than the younger group, although this is at the expense of an increased risk of medical complications, infection, longer length of stay, and mortality.

The increased prevalence of women (448 of 811 (55.2%) versus 205 of 326 (62.9%) observed in the population ≥ 80 years is a reflection of the actual prevalence by gender in the United Kingdom population for this age group, with a 2:1 female to male ratio in those greater than 85 years old. Despite a similar mean number of comorbidities for both the control and ≥ 80 year groups, the ASA grade was higher in the latter. This may reflect the fact that patients ≥ 80 years receive a grade 2 status, even though their physiological status may not have indicated this increased score. Alternatively it could be that the patients’ comorbidity, with a similar number, is relatively more severe. The mean ASA grade of our older group (2.4) is consistent with that reported in other smaller series of patients ≥ 80 years of age undergoing arthroplasty, suggesting a similar case mix.

The improvement of outcome observed in our study for the ≥ 80 group, being equal to that of a younger group is a finding consistent with other smaller studies. The improvement in Oxford scores was significant, relative to pre-operative scores, and was greater than the minimal clinically important difference for both THR and TKR. The 95% CI for the mean improvement of scores did not differ by more than the minimal clinically important difference for THR or TKR between each group, suggesting that there is no clinical difference in outcomes. Sub-analysis of the pain and functional components of the Oxford hip score demonstrated that the older patients have equal pain relief, but not as good a functional outcome compared with the younger patients. This has been described after TKR in a small series of 50 octogenarian patients, but not previously demonstrated after THR. This sub-analysis of the Oxford score is not validated, nor was the difference in the functional outcome, between the groups, greater than the minimal clinically important difference and hence may not be clinically important.
This study is the first to use SF-12 scores as a patient reported outcome measure to compare patients ≥ 80 years old with a control group. The mental component did not significantly improve relative to pre-operative scores, whereas the physical component did and by more than the minimal clinically important difference. However, these patients did not improve to the same extent as their younger counterparts for the physical component. The mean difference did not exceed the minimal clinically important difference, but the 95% CI for THR at the upper extreme was greater than the 5.4 minimum. This may reflect the content of the questionnaire which has been shown to be age dependant,29 with the absolute score tending to deteriorate with age.

Overall the older group was satisfied with their surgery, with 92.1% and 83.1% being satisfied or very satisfied with their THR and TKR respectively and they were more satisfied than the control group after their THR. This may reflect
lower functional expectations of older patients, compared to younger patients.

The pain relief and functional improvement in these older patients comes at an increased risk of medical complications, need for high dependency unit, re-admission and joint infection. The rate of complications observed in this study is consistent with other published series. Unlike others however, we did not observe a significantly increased mortality in our older group for either THR or TKR. In fact, the non-significant increased risk we observed (HR 1.7 and 1.5, respectively) is less than the standardised age match mortality might have predicted. Although the 95% CI around the rate in older group for either THR or TKR. In fact, the non-significant increased risk we observed (HR 1.7 and 1.5, respectively) is less than the standardised age match mortality might have predicted. Although the 95% CI around the rate of complications in younger group was wide, it may be that our study was underpowered to demonstrate a significant difference. Another reason why we may not have observed an increased mortality rate in this group could be that, due to patient selection, only those physically fit enough were offered surgery.

The older patients had a longer hospital stay when compared with the younger group. Relative to other studies our overall length of stay for THR and TKR was less.14-16 However, the increased length of stay, of two to three days compared with the younger group, is consistent with previous reports7 and would result in an increased cost of approximately £1299 for THR and £866 for TKR, assuming the standard cost of stay to be £433 per day.30 There would also be the additional costs of managing the increased rate of the medical complications, HDU stay at a high dependency unit and re-admissions.

Subgroup analysis of this older group revealed no significant differences in outcome measures, complications, or mortality for any particular subgroup. We acknowledge that we may have presented a selected group of patients where only the fittest, underwent surgery, however this tends to support the idea of joint replacement for all patients fit enough to endure surgery irrespective of their age. Alfonso et al11 reported the outcome of a small series of nonagenarians after TKR, demonstrating good pain relief but as we have shown there was a longer length of stay postoperatively. Unlike our study, they reported a medical complication rate of 56% whereas the complication rate in our nonagenarian group was 16%. This may, however, reflect a differing case mix.

Not only does the longevity of the population continue to increase, but the years of good health are rising, increasing the numbers of people ≥ 80 years old who are fit enough to benefit from joint replacement. There may, however, be repercussions upon the current service commitments to arthroplasty patients, with a need to address the potentially increased rate of complications and rehabilitation of these older patients.

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References


