Clinical outcome following primary total hip or knee replacement in nonagenarians

D Skinner, BJ Tadros, E Bray, M Elsherbiny, G Stafford

Elective Orthopaedic Centre, Epsom, UK

ABSTRACT

INTRODUCTION The Elective Orthopaedic Centre in Epsom has an established patient reported outcome measures programme, into which all patients are enrolled. Postoperative complications, Oxford hip/knee scores (OHS/OKS) and EQ-5D™ (EuroQol, Rotterdam, Netherlands) scores are collected up to the second postoperative year. Our population is ageing and the number of joint replacements being performed on the very elderly is rising. The aim of this study was to investigate the outcome of joint replacements in a nonagenarian population.

METHODS Our dataset was reviewed retrospectively for a cohort of nonagenarians undergoing either a primary total hip replacement (THR) or total knee replacement (TKR) between April 2008 and October 2011. Postoperative complications, mortality rates and functional outcomes were compared with those of a time matched 70–79-year-old cohort.

RESULTS Nonagenarians requiring a THR presented with a lower preoperative OHS ($p=0.020$) but made a greater improvement in the first postoperative year than the younger cohort ($p=0.040$). The preoperative OKS was lower for nonagenarians than for the control group ($p=0.022$). At one and two years after TKR, however, there was no significant difference between the age groups. The nonagenarians had a greater risk of requiring a blood transfusion following both THR ($p=0.027$; 95% confidence interval [CI]: 1.11–5.75) and TKR ($p=0.037$; 95% CI: 1.08–16.65) while the latter cohort also required a longer stay than their younger counterparts ($p=0.001$). Mortality rates were higher in the nonagenarian group but these were in keeping with the life expectancy projections identified by the Office for National Statistics.

CONCLUSIONS Over a two-year period, the functional outcome and satisfaction rates achieved by nonagenarians following a THR or TKR are comparable with 70–79-year-olds.

KEYWORDS

Total hip arthroplasty – Total knee arthroplasty – Nonagenarian – Mortality – Outcome

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CORRESPONDENCE TO

Baha Tadros, E: b_tadros@yahoo.com

The UK's population is ageing, with the greatest rise observed in those aged over 85 years.¹ The average life expectancy for males born in 2013 is 90.7 years and for females, it is 94.0 years.² Between 2011 and 2012, there was a 7.5% increase in total hip replacements (THRs) and a 7.3% increase in total knee replacements (TKRs).³ Despite an ageing population and increase in the number of operations being performed, the mean age of patients undergoing surgery has remained constant.⁴ This may well reflect improvements in bone conserving surgery but could imply an enduring concern over complications and the risk-to-benefit ratio of operating on the very elderly. Nevertheless, patients themselves have conveyed a readiness to undergo surgery.^{4,5}

Conservative management for osteoarthritis consists of analgesia and physiotherapy. Chronic osteoarthritis necessitates complex analgesic regimes but the fastidious nature of clinical trials commonly excludes the nonagenarian

population.⁶ The resultant deficiency of evidence for this population, along with concerns over polypharmacy⁷ and renal impairment,⁷ frequently leads to suboptimal analgesic regimes and the habitual undertreatment of these patients.^{6,8} Physiotherapy has been shown to provide short-term benefit in function and pain levels in knee osteoarthritis⁹ but factors seen frequently in the elderly such as low levels of physical activity, anxiety and poor social support are all strong predictors for poor adherence to exercise regimes.¹⁰

The current economic environment and recent healthcare reforms have resulted in the National Health Service finding itself under increasing scrutiny when justifying healthcare provision.¹¹ A number of studies have looked at functional outcome, co-morbidities and complication rates in the elderly population undergoing lower limb joint replacement surgery^{4,12–19} but many of these studies also incorporate octogenarians^{4,12,14,18} and centenarians.^{15,16} A comparative literature

Table 1 Patient demographics

	Hip replacement		Knee replacement	
	70–79 years (n=55)	90–99 years (n=38)	70–79 years (n=36)	90–99 years (n=31)
Mean age (range) in years	74.69 (70–79)	92.18 (90–99)	74.56 (70–79)	91.00 (90–96)
Mean BMI (range) in kg/m ²	25.35 (19–36)	23.78 (20–29)	27.16 (21–39)	26.14 (20–35)
Male-to-female ratio	21:34	12:26	23:13	12:19
Left-to-right ratio	25:30	20:18	17:19	15:16
ASA grade				
1	3	1	0	0
2	29	23	25	21
3	21	13	11	10
4	2	1	0	0

BMI = body mass index; ASA = American Society of Anesthesiologists

review from 2012 concluded that excellent clinical outcomes were achieved in the nonagenarian population.¹⁹ However, it did not have a control cohort to establish whether improvements were comparable with those of a younger population and it only provided a one-year clinical follow-up for a small number of patients.

We propose that nonagenarians make equivocal gains in functional outcomes to those of a younger population without an increased risk of perioperative complications or mortality. To our knowledge, this is the largest comparative study focusing solely on the nonagenarian population.

Methods

The database at the Elective Orthopaedic Centre in Epsom was searched retrospectively over a consecutive 42-month period for nonagenarian patients undergoing a THR or TKR. Only patients with a primary diagnosis of osteoarthritis were included whereas exclusion criteria consisted of those undergoing revision surgery, simultaneous bilateral replacements or conversion from a dynamic hip screw and hemiarthroplasty.

Demographic data collected consisted of age, sex, co-morbidities, ASA (American Society of Anesthesiologists) grade and body mass index (BMI). Patient reported outcome measures (PROMs) for eligible patients were gathered from our mature PROMs database. Our centre routinely collects preoperative, one-year and two-year postoperative Oxford hip/knee scores (OHS/OKS) and EQ-5D™ (EuroQol, Rotterdam, Netherlands) scores along with complications at each of these timepoints. Secondary outcomes collected were preoperative haemoglobin (Hb) level, lowest postoperative Hb, units of blood transfused, length of stay (LOS) and mortality. For a comparative analysis, a time matched cohort of patients aged between 70 and 79 years was used as a control.

Statistical analysis was performed using SPSS® version 20 (IBM, New York, US). An analysis of variance was used to compare all outcomes and those found to be statistically significant underwent a post hoc t-test for pairwise comparison. A Cochran–Mantel–Haenszel test was used to

establish the odds ratio for mortality while Spearman's rank correlation coefficient was used to investigate any correlation between LOS and age. Prospective acquisition of PROMs data is routine practice at our centre. The review performed was a retrospective data analysis and ethical approval was therefore not necessary.

Results

Overall, 69 nonagenarian patients (24 men, 45 women) who underwent a joint replacement between April 2008 and October 2011 were identified, with a mean age of 91.68 years (range: 90–99 years). The joint replacements were for 38 hips (12 men, 26 women) and 31 knees (12 men, 19 women). The mean BMI was 24.81kg/m² (standard deviation [SD]: 3.81kg/m²).

The control cohort consisted of 91 patients (34 men, 57 women), with a mean age of 75 years (range: 70–79 years), who underwent a lower limb joint replacement over the same period. There were 55 hips (21 men, 34 women) and 36 knees (13 men, 23 women). The mean BMI was 26.08kg/m² (range: 19–39kg/m²).

The demographic information for the nonagenarian and control groups broken down by hip and knee patients is shown in Table 1. There was no statistical difference in ASA grade but there was a significant difference in BMI between the hip nonagenarian cohort and the control cohort (mean difference: 1.57kg/m², 95% confidence interval [CI]: 0.28–2.84kg/m², $p=0.024$).

Hip primary outcomes

The nonagenarians who underwent THR demonstrated a significantly lower mean preoperative EQ-5D™ score than the control group (mean difference: 0.17, 95% CI: 0.04–0.30, $p=0.014$). Postoperatively, the older patients had a mean increase of 0.57 (SD: 0.25) at one year, which was significantly greater than the 0.42 (SD: 0.33) increase achieved by their younger counterparts (mean difference: -0.15, 95% CI: -0.30–0.01, $p=0.040$). Both cohorts maintained significant improvements in EQ-5D™ at two years (Fig 1).

Figure 1 Hip EQ-5D™ comparison

The mean preoperative OHS was significantly lower in the nonagenarian group (mean difference: 4.91, 95% CI: 0.78–9.04, $p=0.020$) but no difference was observed between the age groups at any postoperative timepoint. There was also no significant difference between the cohorts in the amount of change achieved between follow-up appointments (Fig 2).

The mean satisfaction rate at one year for the nonagenarian patients was 92.0% (SD: 11.1 percentage points). At

Figure 2 Oxford hip score comparison

two years, this declined by 3.5 percentage points (95% CI: -6.9–13.7 percentage points) to 88.5% (SD: 21.3 percentage points) ($p=0.500$). When compared with the control cohort, there was no significant difference in outcome satisfaction at two years (mean difference: 2.2 percentage points, 95% CI: -7.2–11.7 percentage points, $p=0.637$).

Hip secondary outcomes

Using a two-tailed Spearman's rank correlation calculation, a positive association was observed between age and LOS ($p<0.0001$). The mean LOS for THR was 8.22 days (SD: 4.38 days) for the nonagenarians and 6.36 days (SD: 5.92 days) for the younger cohort, which was not significant (mean difference: -1.86 days, 95% CI: -4.15–0.43 days, $p=0.110$).

The mean preoperative Hb was 12.66g/dl (SD: 1.48g/dl) for the nonagenarians and 13.18g/dl (SD: 1.20g/dl) for the control patients (mean difference: 0.52g/dl, 95% CI: -0.03–1.07g/dl, $p=0.063$). Postoperatively, the nonagenarian cohort had a significantly lower mean Hb than that of the control group (mean difference: 0.66g/dl, 95% CI: 0.10–1.22g/dl, $p=0.022$) but the extent of the decline between pre and postoperative Hb was comparable in both groups (mean difference: 0.13g/dl, 95% CI: -0.46–0.72g/dl, $p=0.667$) (Table 2). Twenty-one nonagenarians (55.3%) received a mean of 2.10 units (SD: 0.89 units) of packed red blood cells while 13 patients (23.6%) from the control group received a mean of 2.23 units (SD: 0.62 units). Nonagenarians were 2.3 times more likely to receive a transfusion (95% CI: 1.11–5.76, $p=0.027$) (Table 2).

The perioperative medical complication rates for THR were 13.2% (5/38) in the nonagenarian group and 21.8% (12/55) in the younger cohort. The nonagenarian complications consisted of hyponatraemia, atrial fibrillation, bowel obstruction, urinary tract infection and a pressure sore. The control group experienced four cases of atrial fibrillation, ventricular fibrillation arrest, non-ST elevation myocardial infarction, stable angina, aspiration pneumonia, *Clostridium difficile*, acute delirium, urinary tract infection and a sacral sore.

The surgical complication rates for THR were 10.5% (4/38) and 7.3% (4/55) in the nonagenarian and control cohorts respectively. Those in the former group sustained two superficial wound infections, one wound sinus and one periprosthetic fracture following a fall on the ward. Among the control patients, there was one superficial wound infection, one persistently oozing wound, one case of severe pain due to spasm and one dislocation on day 2.

Following discharge, one nonagenarian hip patient underwent an exchange of femoral heads for recurrent dislocations before an additional procedure to excise a stitch abscess. One patient from the control group was offered a revision for persistent pain at two years but refused.

The one-year mortality rate for THR was 13.2% (5/38) for the nonagenarians and 1.8% (1/55) for the control patients (Table 3). By two years, the mortality rates had increased to 21.1% (8/38) and 3.6% (2/55) respectively. The mean duration until death was 250 days (range: 2–706 days) in the nonagenarian cohort and 330 days (range: 36–625 days) in the control group.

Table 2 Mean Hb levels and transfusion rates for all cohorts

	Hip replacement					Knee replacement				
	Preoperative Hb	Postoperative Hb	Difference	Patients transfused	Units transfused	Preoperative Hb	Postoperative Hb	Difference	Patients transfused	Units transfused
70–79 years	13.18g/dl	9.32g/dl	-3.86g/dl	13	29	13.33g/dl	9.66g/dl	-3.67g/dl	3	11
90–99 years	12.66g/dl	8.65g/dl	-4.01g/dl	21	44	12.94g/dl	9.18g/dl	-3.76g/dl	11	29
<i>p</i> -value	0.063	0.022	0.667			0.408	0.088	0.949		

Hb = haemoglobin

Table 3 Hip mortality

Patient	Age	Duration until death	Cause
1	96	2 days	Acute-on-chronic kidney injury
2	95	5 days	Myocardial infarction
3	73	36 days	Multiorgan failure, decompensated liver disease, primary biliary cirrhosis
4	90	58 days	Renal sepsis
5	92	147 days	GP contacted – unknown cause
6	90	200 days	Bronchopneumonia
7	91	375 days	Bronchopneumonia
8	92	509 days	Aspiration pneumonia and seizures secondary to stroke
9	78	625 days	GP contacted – unknown cause
10	92	706 days	GP contacted – unknown cause

GP = general practitioner

Knee primary outcomes

In the nonagenarian TKR cohort, the EQ-5D™ score improved significantly by 0.36 (95% CI: 0.19–0.47) from a preoperative mean of 0.51 (SD: 0.51) to 0.67 (SD: 0.25) at one year ($p=0.0001$). The overall one-year score was not significantly different to that of the control group (mean difference: 0.06, 95% CI: -0.08–0.19, $p=0.413$) and neither was the degree of improvement (mean difference: -0.05, 95% CI: -0.24–0.20, $p=0.840$). The nonagenarians had a non-significant decline in EQ-5D™ between year 1 and year 2 (95% CI: -0.08–0.27, $p=0.251$), resulting in a significantly lower two-year score than that of the control patients (mean difference: 0.16, 95% CI: 0.02–0.29, $p=0.022$) (Fig 3).

The mean preoperative OKS for nonagenarians was 15.84 (SD: 6.97) while the control cohort recorded a significantly higher 20.17 (SD: 7.95) (mean difference: 4.33, 95% CI: 0.65–8.00, $p=0.022$). At one and two years, there was no significant difference between the age groups. The difference in degree of improvement attained by both cohorts between the preoperative OKS and the OKS at one year was not statistically different ($p=0.405$), and neither were the improvements between year 1 and year 2 ($p=0.079$) (Fig 4).

The nonagenarian TKR patients reported mean outcome satisfaction scores of 85.2% (SD: 22.8 percentage points) at one year and 83.0% (SD: 22.1 percentage points) at two years. There was no significant difference in satisfaction between the age groups at either one year (mean difference: -3.8 percentage points, 95% CI: -15.3–7.7 percentage points, $p=0.507$) or two years (mean difference: -1.6 percentage points, 95% CI: -8.9–14.3 percentage points, $p=0.639$).

Knee secondary outcomes

The mean LOS for TKR was 8.55 days (SD: 3.84 days) for the nonagenarians and 5.61 days (SD: 2.74 days) for the control patients (mean difference: -2.74 days, 95% CI: -4.35–1.12 days, $p=0.001$). As seen with the hip cohorts, a strong correlation existed between LOS and age ($p<0.0001$).

No statistically significant difference was seen in the pre or postoperative Hb levels between the two TKR cohorts and the Hb decline within the two cohorts was also not significant (Table 2). Eleven nonagenarians (35.5%) and three control patients (8.3%) received a blood transfusion, with the former being 4.3 times more likely to receive a transfusion (95% CI: 1.08–16.65, $p=0.037$) (Table 2).

Table 4 Knee mortality

Patient	Age	Duration until death	Cause
1	90	70 days	Bronchopneumonia
2	91	158 days	GP contacted – unknown cause
3	91	351 days	Kaposi's sarcoma
4	90	543 days	Lung cancer

GP = general practitioner

The perioperative medical complication rates for TKR were 16.1% (5/31) in the nonagenarian group and 11.1% (4/36) in the control cohort. The nonagenarian complications included two cases of hyponatraemia, acute kidney injury, fast atrial fibrillation and myocardial infarction along with haematuria. In the control group, there were two cases of delirium, hyponatraemia and fast atrial fibrillation with secondary myocardial infarction.

The surgical complication rates for TKR were 6.5% (2/31) and 11.1% (4/36) in the nonagenarian and control cohorts respectively. The nonagenarians experienced an oozing wound and blistering secondary to the dressing. Among the control patients, there were two oozing wounds, cellulitis and a nerve injury resulting in foot drop.

The mortality rates for nonagenarian knee patients were 9.7% at one year and 12.9% at two years (Table 4). There were no deaths in the control group.

Discussion

With 1 in 3 babies born in the UK now expected to live longer than 100 years² in addition to the over-85-year-olds being the fastest growing population cohort,¹ an understanding of postoperative outcomes in nonagenarians is essential if they are to be managed effectively. This study found that nonagenarians requiring a THR achieved comparable functional outcomes to those of 70-79-year-olds despite starting with a significantly lower preoperative EQ-5D™ and OHS.

This pattern was not observed in the TKR cohort. Although they had an equivalent EQ-5D™ score and OKS prior to surgery, by one year following surgery, the nonagenarians achieved a significantly lower OKS. This may reflect the effect age has on the efficiency of improving muscle strength and control around the knee joint in the early phases of rehabilitation, particularly as no difference was seen in OKS between the age groups at two years. However, the ceiling effect of the Oxford scoring system²⁰ may have limited the potential difference between the cohorts at the two-year point.

To our knowledge, this is the first study to compare OHS/OKS and EQ-5D™ scores specifically in a nonagenarian population against a control cohort. Clement *et al*

demonstrated equivocal results in both the pain and functional components of the OKS in a population aged over 80 years when compared with a younger control cohort.⁴ They also suggested that their control group made greater gains in the OHS, which opposes our finding. Nevertheless, the mean 22.5 improvement in OHS at one year in our study is in keeping with the mean 21.9 improvement reported in the literature.¹²

The mean LOS for nonagenarians is reported as 12–13 days for a THR^{18,21} and 10.2–14.8 days for a TKR.^{13,15,17,22} Our mean LOS was 8.22 and 8.35 days respectively. This is likely to reflect that our centre is a nationally recognised specialist unit with a high volume output.

Our transfusion rates were 55% for THR and 35% for TKR patients. This is lower than the figures reported throughout the literature (68–71%^{18,21} and 54%¹⁵ respectively). There was no statistically significant difference between the two age cohorts in terms of the mean Hb decrease between the pre and postoperative measurements. However, the nonagenarians were 2.3 and 4.3 times more likely to receive a blood transfusion for THR and TKR respectively. The wide CI for the odds ratio for our TKR patients may indicate an overestimation of the significance of this result. Despite this, our hip surgery transfusion rates are similar to those in other published work where transfusions were performed at the discretion of an anaesthetist.¹⁸

A cause of death was established for 71% or our mortalities (Tables 3 and 4). Only two deaths occurred in the perioperative period. The first was due to an acute-on-chronic kidney injury occurring on day 2 while the second was due to a myocardial infarction on day 5. Our 1-year mortality rate of 13.2% in the nonagenarian THR cohort is marginally higher than the 1.5–9.6% reported in the literature^{18,25} but our mortality rates at 30 days (5.3%)^{14,16,18,19,21} and at 2 years (21.1%) are comparable.^{14,17} There was an increased mortality risk at two years for both nonagenarian cohorts but the Office for National Statistics estimates that the mean life expectancy for nonagenarians in England ranges from 2.21 to 4.09 years for men and 2.44 to 4.71 years for women.²⁴ This suggests that our mortality rates are in keeping with this observed trend.

The strengths of our study are that the data were collected from a specialist high volume centre with an established and prospective PROMs collection programme. The surgeons operating at the centre come from five different hospitals located in South London, introducing a degree of variation in practice that is representative of the national clinical setting. At our centre, postoperative care is managed by consultant intensivists, thereby removing potential bias that surgeon-led care may introduce.

A limitation of our study was the small number of patients selected from the younger control group. As patients were selected based on their co-morbidities to match them to the nonagenarian group, the overall clinical outcome reported does not reflect the true outcome for this cohort. Using the date of discharge to calculate the LOS rather than the date the patients were discharged from the physiotherapist also introduces bias because discharge in older patients is sometimes delayed for social reasons.

Conclusions

The nonagenarian population made improvements in functional outcomes following THR and TKR that were comparable with those achieved by a younger cohort over two years following surgery. No difference in outcome satisfaction was reported. There was increased mortality in the nonagenarian patients; this reflected the life expectancy estimations projected by the Office for National Statistics for this population. The benefits of THR and TKR are therefore deemed to outweigh the risk of surgery, and it is suggested that they should be a realistic treatment option offered to this population cohort.

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