A prospective observational study of falling before and after knee replacement surgery

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Abstract

Background: knee arthritis is a risk factor for falling. Increasing numbers of people are receiving total knee arthroplasty (TKA) but the natural history of falling before and after TKA is unknown.

Objective: to prospectively monitor falls in pre- and post-operative TKA patients and to identify independent risk factors for post-operative falling.

Design: a prospective observational study with a 1-year follow-up.

Participants: community-dwelling older people recruited from a regional orthopaedic centre.

Methods: consecutive patients added to the TKA waiting list who completed monthly falls diaries, pre-operatively and 1 year post-operatively. Data on knee status (WOMAC: pain, stiffness and function), balance confidence (the Activities Balance Confidence Scale-UK—ABC-UK) and mood (Geriatric Depression Scale—GDS) were collected at quarterly intervals.

Results: ninety-nine patients received a primary TKA. 24.2% fell in the last pre-operative quarter (24 patients reported 44 falls) and this decreased to 11.7–11.8% in the first four post-operative quarters. 45.8% of people who fell pre-operatively fell again in the first post-operative year. Higher pre-operative GDS scores and a history of falling were significant independent predictors of post-operative falling.

Conclusion: a recent history of falling is common in people undergoing TKA and ~45% of patients fall again in the year following surgery. Patients being considered for TKA should be asked about falls history and undergo falls risk assessment and intervention.

Keywords: total knee arthroplasty, falls, WOMAC, depression, balance confidence, elderly

Introduction

Total knee arthroplasty (TKA) is a common approach to the management of severe knee arthritis. In 2005, the National Joint Registry [1] reported 62,155 TKAs in England and Wales.

Current estimates indicate that ~33% of community-dwelling older people fall each year [2]. Knee arthritis is an established risk factor for falling with pain, stiffness and functional limitation being more relevant to falls risk than radiological changes [3]. Significant improvements in pain, function and proprioception have been reported following TKA [4–6]. These factors when combined would be expected to reduce the prevalence of falling in older people after TKA. However, some studies have shown proprioceptive/balance deficits following TKA and this could increase falls risk [7, 8]. A recent systematic review shows that no study has addressed falling as an outcome following TKA [4]. The specific questions we wished to address were:

- What proportion of patients fall before and after TKA?
- Does TKA change falls-related outcomes such as knee pain, knee function, balance confidence and mood?
- What are the pre-operative predictors for post-operative falling in TKA patients?

Patients and methods

Participants, aged 65 years and over, were recruited consecutively, as they were added to the waiting list for knee arthroplasty at the Avon Orthopaedic Centre, Bristol, UK. They were contacted by letter and invited to participate in a longitudinal study of falls before and after knee replacement surgery. Of the 277 people approached, 171 agreed to...
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<table>
<thead>
<tr>
<th>277 patients approached</th>
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<tbody>
<tr>
<td>171 agreed to participate</td>
</tr>
<tr>
<td>118 in final data set</td>
</tr>
<tr>
<td>99 Primary TKA</td>
</tr>
</tbody>
</table>

Figure 1. Study flow.

take part in the study, 75 declined and 31 did not respond (see Figure 1).

Outcome assessment

On recruitment, participants completed a self-administered baseline questionnaire regarding falls in the preceding 4 months, prescribed and non-prescribed medications, co-morbid conditions, hearing and visual impairment and previous surgery. Falls data were collected prospectively, at monthly intervals, from the time of entry onto the waiting list and for 12 months after surgery. A fall was defined as unintentionally coming to rest on the ground, or at some other lower level, not as a result of a major intrinsic event such as a fit, faint or stroke [9]. Falls diaries were sent out monthly with a pre-paid envelope for the return of the previous month’s sheet. Participants who did not return their monthly falls diary were sent a written reminder.

Every 3 months, participants were sent an update questionnaire regarding changes in medication or health status, the Western Ontario and McMaster Osteoarthritis Index (WOMAC [10]), the Activities Specific Balance Confidence Scale-UK (ABC-UK [11]) and the Geriatric Depression Scale (GDS [12, 13]). Appendices 1 and 2 (available on Age and Ageing online) give details of patient characteristics and outcome measures used.

Data analysis

Data were analysed using Excel and SPSS (version 13, SPSS, Chicago, IL, USA) statistical software. Patients were classified as either ‘fallers’ (one or more falls) or ‘non-fallers’ based on data from monthly falls diaries. Changes in falling status were compared using Pearson’s chi-square tests. Binary Logistic Regression was conducted to identify independent pre-operative predictors of post-operative falls controlling for inequality of variables. See Appendix 3 (available on Age and Ageing online) for sample size explanation and details of all statistical tests.

The ethics committees of the North Bristol Hospital Trust (Southmead) and the University of the West of England, Bristol, gave approval for this study.

Results

Of the 118 patients recruited for this study, 99 received a primary TKA (mean age 73.4 ± 4.9 years, range 66–85, 36 males: 63 females) and 19 a revision TKA (mean age 74.0 ± 3.6 years, range 67–80 years, 10 males: 9 females). Outcomes following revision TKA may be poorer than those for primary TKA [14], we are therefore presenting the results of the primary TKA group only.

Fallers and falls

Overall, there was a 98.2% return rate for monthly falls diaries. 24.2% of patients fell in the pre-operative quarter compared to 11.7–11.8% in each of the four post-operative quarters. The annual post-operative falls rate was 24.2%.

Table 1 shows pre-operative characteristics of fallers and non-fallers.
Patients reporting falling 4 months prior to entry 4/75 (5.3%) 13/23 (56.5%)

Total no. of prescribed regular medications 4.3 (median 4) 5.7 (median 6.0)

Previous TKA 18/75 (24.0%) 3/23 (13.0%)

Prior knee surgery (any) 31/75 (41.3%) 8/23 (34.8%)

Diagnosis OA:RA 61:14 20:4

No. of co-morbid conditions, mean (median) 2.5 (2.0), range 0–7 3.3 (3.0), range 0–8

Sex ratio (M:F) 34:41 2:22

Self-reported hearing problems 18/75 (24.0%) 4/23 (17.4%)

Self-reported eye problems 20/75 (26.7%) (3 glaucoma; 6 cataract) 3/23 (13.0%) (0 glaucoma; 1 cataract)

Prior hip surgery 7/75 (9.3%) 2/23 (8.7%)

A total of 54.2% (13/24) of pre-operative fallers did not fall again in the first post-operative year; 45.8% (11/24) remained fallers. 17.3% (13/75) of non-fallers fell post-operatively. Overall, there was a significant switch in favour of pre-operative fallers becoming non-fallers in the first post-operative year (Pearson’s chi-square = 8.041, df = 1, \( P = 0.005 \)). Separate comparison of quarterly data showed a significant change in the overall distribution of fallers/non-fallers in the last quarter of the first post-operative year (Pearson’s chi-square = 22.40, df = 1, \( P < 0.001 \)) when 13 of 24 pre-operative fallers became non-fallers.

A total of 44 falls were sustained in the pre-operative quarter compared to 16, 22, 32 (two patients fell six times each this quarter) and 17 in each of the post-operative quarters. Details of pre- and post-operative falls (based on reference [15]) are shown in Table 2. In comparison with pre-operative values, there was a significant reduction in the number of falls in the first, second and fourth post-operative quarters of the first year following surgery (paired \( t \)-tests, \( P = 0.005 \), 0.052 and 0.001, respectively).

Pre-operative and surgical predictors of falls

With the exception of gender, none of the pre-operative characteristics reported in the baseline questionnaire were independently predictive of pre-operative falling. Adjusted and non-adjusted odds ratios for this data can be found in Appendix 4 (available on Aging and Ageing online). Male gender was associated with decreased likelihood of pre-operative falling even when adjusted for pre-operative variables such as age and number of co-morbid conditions (adjusted OR 0.083, 95% CI 0.020–0.694, \( P = 0.022 \)). Gender did not, however, influence the odds of falling post-operatively (adjusted OR 0.547, 95% CI 0.168–1.955, \( P = 0.375 \)).

When adjusted for age and other pre-operative variables, the odds of a pre-operative faller becoming a faller in the first post-operative year are almost eight times those of a non-faller (adjusted OR 7.75, 95% CI 1.721–35.710, \( P = 0.008 \)).

Pain, stiffness and function (WOMAC)

Across the whole cohort, there were significant improvements in mean WOMAC scores over time [pain: ANOVA, \( F(4, 264) = 42.39 \), mean square error (MSE) = 8.05, \( P < 0.001 \); stiffness: \( F(4, 264) = 28.66 \), MSE = 1.52, \( P < 0.001 \); function: \( F(4, 240) = 37.46 \), MSE = 73.96, \( P < 0.001 \)]. Mean post-operative scores were better than pre-operative scores at all time points (\( P < 0.001 \)). Post-operative pain improved significantly between 3 and 6, and 9 and 12 months (\( P \leq 0.044 \)) and function between 3 and 12 months (\( P = 0.021 \)). Similar overall improvements were seen in pre-operative fallers and non-fallers. However, fallers did not show the significant post-operative improvements between 3, 9 and 12 months which were apparent in non-fallers (\( P \leq 0.038 \)).

Following adjustment for age, gender, number of co-morbid conditions and pre-operative scores (for post-operative comparisons), there were no differences in
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**Table 2. Characteristics of pre- and post-operative falls**

<table>
<thead>
<tr>
<th></th>
<th>Pre-operative falls (3 months post-operative)</th>
<th>Post-operative falls (first year post-operative)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of patients experiencing more than one fall</strong></td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total no. of falls</strong></td>
<td>44</td>
<td>87</td>
</tr>
<tr>
<td><strong>No. of fallers</strong></td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inside</td>
<td>20</td>
<td>47</td>
</tr>
<tr>
<td>Outside</td>
<td>17</td>
<td>40</td>
</tr>
<tr>
<td>Not stated</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td><strong>Causes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrinsicb</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>Extrinsicc</td>
<td>15</td>
<td>55</td>
</tr>
<tr>
<td>Non-bipedald</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Unclassifiablee</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td><strong>Injuries</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No injuries</td>
<td>10</td>
<td>37</td>
</tr>
<tr>
<td>Cuts and/or bruises</td>
<td>31</td>
<td>40</td>
</tr>
<tr>
<td>Fractures</td>
<td>2 (neck of femur, neck of humerus)</td>
<td>6 neck of humerus, clavicle, neck of femur (2), wrist (colles), ribs</td>
</tr>
<tr>
<td>Other injuries</td>
<td>1 avulsion finger tip</td>
<td>4 shoulder/thumb sprains</td>
</tr>
<tr>
<td><strong>Medical help</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>41</td>
<td>72</td>
</tr>
<tr>
<td>Yes</td>
<td>3 hospital</td>
<td>15 (8 hospital, 4 GP, 1 district nurse, 1 health visitor, 1 walk-in centre)</td>
</tr>
</tbody>
</table>

*a* Cumulative data for the first year following surgery. A total of 16, 22, 32 and 17 falls were sustained in the 1st–4th post-operative quarters, respectively.

*b* Related to subject specific factors.

*c* Related to environmental factors.

*d* Falls from a sitting or lying position.

*e* Unclear or missing information.

pre-operative fallers and non-fallers in mean pre-operative balance confidence scores [adjusted ANOVA, *F*(1, 84) = 0.170, *P* = 0.681]. Post-operatively, following adjustment for these variables and also pre-operative balance confidence, there was a significant reduction in balance confidence in fallers compared to non-fallers at the end of the first post-operative year [fallers mean ± SD, 61.2 ± 30.4; non-fallers mean ± SD, 76.7 ± 22.7; *F*(1, 67) = 8.551, *P* = 0.005].

Patients with a higher pre-operative ABC-UK score were less likely to fall post-operatively; a one-point increase in balance confidence significantly reduced the odds of becoming a faller in the first post-operative year by 98% (OR 0.98, 95% CI 0.965–1.012, *P* = 0.04). However, when adjusted for age and all other falls-related baseline variables, pre-operative balance confidence did not significantly affect the odds of post-operative falling (OR 0.98, 95% CI 0.954–1.007, *P* = 0.145).

**Geriatric depression scale**

Overall, GDS scores decreased significantly over time [ANOVA, *F*(4, 268) = 5.271, MSE = 1.764, *P* < 0.001]. There was a significant reduction between mean pre-operative scores and those in each of the last three quarters of the first post-operative year (*P* ≤ 0.026). Patients classified as non-fallers pre-operatively showed a significant reduction in depression symptomatology over time [*F*(4, 196) = 2.763, MSE = 1.420, *P* = 0.029]. There was a significant reduction between pre-operative scores and those in the last post-operative quarter (*P* = 0.048). Fallers showed a similar overall reduction between pre-and post-operative scores over time [*F*(4, 68) = 3.175, MSE = 2.677, *P* = 0.019] but there were no significant differences in mean scores between any quarterly assessment points (*P* ≥ 0.080).

Fallers also had higher mean depression symptomatology scores at all quarterly assessment intervals. After statistical adjustment for age, gender, number of co-morbid conditions and pre-operative GDS score, this reached statistical significance at 3 [ANOVA, *F*(1, 75) = 9.153, *P* = 0.020; fallers 5.37 ± 2.61, non-fallers 3.44 ± 2.53] and 9 months [*F*(1, 75) = 9.153, *P* = 0.003; fallers 5.50 ± 3.54, non-fallers 2.58 ± 2.41] following TKA. There were no significant differences in pre-operative depression symptomatology between fallers and non-fallers [adjusted ANOVA, *F*(1, 84) = 0.170, *P* = 0.681].

In fallers, depression scores >5 were 36.4% (pre-operative) and 31.8%, 22.7%, 36.4% and 42.8% in each successive post-operative quarter. Corresponding values for non-fallers were consistently lower at 19.1% and 11.6%, 12.6%, 15.5% and 19.0%.

Following adjustment for all pre-operative falls risk factors (age, gender, co-morbid conditions etc), a one-point increase in pre-operative GDS significantly increased the odds of becoming a post-operative faller by 26.8% (OR 1.268, 95% CI 1.022–1.573, *P* = 0.031).

There was a significant positive correlation between GDS and WOMAC pain scores pre-operatively and at all post-operative time intervals (Spearman’s rank correlation
Discussion

We have investigated the natural history of falling in a cohort of patients undergoing primary TKA. Twenty-four per cent patients fell in the 3 months prior to surgery and 46% of these continued to fall post-operatively. Patients who fell pre-operatively had an 8-fold increase in the risk of post-operative falling; higher depression symptomatology scores increased the risk by one-third.

Knee arthritis is a risk factor for falling [3], so the finding of a 24% falls rate in the last pre-operative quarter in these patients is unsurprising. However, despite contact with multiple healthcare professionals on the clinical pathway to TKA, we are unaware of patients being asked about falls or screened for falls risk. Falls prevention strategies appear to be most effective when they target high-risk populations or individuals [16, 17]. Our study indicates that TKA patients come into this category. Our patients improved in function and balance confidence up to 1 year post-operatively; however, in pre-operative fallers, there was no pre- to post-operative improvement in balance confidence or in balance confidence or function in the year following TKA. It would, therefore, seem appropriate that falls prevention interventions were commenced during the pre-operative period; the optimal timing and nature of assessments and interventions which address falling in this group are unknown and are an important area for further research.

TKA may lead to a reduction in the prevalence of falls and fallers. Compared to the last pre-operative quarter, the number of falls in each post-operative quarter was more than halved and there was a change in the distribution of fallers/non-fallers with 54.2% of pre-operative fallers becoming non-fallers. The annual post-operative falls rate was 24.2% which is less than current estimates of 33% for community-dwelling older people [2]. However, it was not possible to recruit a control group of non-TKA patients with similar severity of knee arthritis and equivalent health status; we were therefore unable to establish the natural history of falling in non-surgical patients. We have, however, shown significant improvements in parameters that are linked to falls risk; WOMAC subscales of pain and function are significantly associated with reaction time, balance, knee extension strength and proprioception [18].

Knee pain and function improved significantly post-operatively. Our findings compare well with other studies and are very similar to those of a recent study incorporating 108 TKA patients [19]. The contribution of knee pain to falls risk is uncertain. Although arthritic knee pain has been shown to increase the propensity to trip [20], pain relief does not improve gait or stair stepping [21]. With respect to function, functional status did not independently predict falls and there were no functional differences between groups at any pre- or post-operative assessment intervals. Although inactivity could reduce the likelihood of falling, these findings suggest that post-operative change in falls prevalence is unlikely to be attributable to reduced mobility following surgery.

While TKA resulted in an overall improvement in depression symptomatology (GDS), this was not seen in pre-operative fallers. The association between depression and falling is well recognized [22] and is complex. Depression can lead to inattention and inactivity which then results in falling [23]; it may also increase the risk of falling due to additional prescription medications such as anti-depressants [24]. We found that greater depression symptomatology was correlated with diminished function at all assessment points. However, while reduced function secondary to depression could be a critical factor in falling, function was not found to be a predictor of falling. The significant correlation between pain and GDS raises the question of whether depression is a mediator of pain and falling; however, we are unable to determine the likely direction of this relationship from our data.

Our study has focused on patients undergoing primary TKA. Increasing numbers of people are receiving revision arthroplasties. There is currently little data available on outcome measures following revision arthroplasty. One recent study suggests that, with the exception of pain, the profile of recovery following revision TKA is not significantly different compared to primary TKA [14]. A further study reports no significant differences between groups at 6 months following surgery [25]. Outcomes following revision TKA in the small sample of 19 patients from our original cohort are similar to those of the primary TKA group. However, balance confidence and depression scores are worse in this group and it would be interesting to explore the natural history of falls in a large cohort of revision patients.

Proprioceptive deficits have been implicated both as a cause and a consequence of knee arthritis [26, 27] and some studies show that TKA improves knee proprioception [5, 6]. While improved proprioception could be a factor in the overall reduction in falls following surgery, a recent review of the topic argues that the evidence for altered knee proprioception following TKA is inconsistent and controversial [28]. Further studies are needed to explore this.

Appendix 6 (available on Age and Ageing online) contains full details of methodological considerations.

Key points

- A total of 24.2% of people undergoing TKA fell in the 3 months before surgery. Post-operative falls rates were 11.7–11.8% per quarter in the first year.
Acknowledgements

Our sincere thanks to all participants and also to Dr Paul White for his advice on statistical analysis; Denise Roy, Lead Assessment Nurse in Orthopaedics, for help with study design; Hayley Johnson for assistance with data inputting and Orthopaedic Consultants and administrative staff at the Avon Orthopaedic Centre, Bristol, UK, for their collaboration in this study.

Conflicts of interest

There are no conflicts of interest in this study.

Funding

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Supplementary data

Supplementary data are available at Age and Ageing online.

References

Inequalities in health at older ages: a longitudinal investigation of the onset of illness and survival effects in England

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Abstract

Background: previous studies have suggested a decline in the relationship between socioeconomic circumstances and health or functioning in later life, but this may be due to survival effects.

Objective: to examine whether wealth gradients in the incidence of illness decline with age, and, if so, whether this decline is explained by differential mortality.

Methods: the study included participants in the first two waves of the English Longitudinal Study of Ageing (ELSA), a large national longitudinal study of the population aged 50+ in England, who reported good health, no functional impairment, or no heart disease at baseline. Wealth inequalities in onset of illness over 2 years were examined across age groups, with and without the inclusion of mortality. Outcome measures were functional impairment, heart disease, self-reported health, and all-cause mortality (in conjunction with self-reported health and disability) or circulatory-related mortality (in relation to heart disease).

Results: wealth predicted onset of functional impairment equally across age groups. For self-reported health and heart disease, wealth gradients in the onset of illness declined with age. Selective mortality contributed to this decline in the oldest age groups. New health problems persist into old age for certain illnesses, particularly functional impairment, but not for heart disease. Selective mortality explains only some of the decline in health inequalities with age.

Conclusions: socioeconomic inequality in developing new health problems persist into old age for certain illnesses, particularly functional impairment, but not for heart disease. Selective mortality explains only some of the decline in health inequalities with age.

Keywords: health inequalities, ageing, selective mortality