

# The Long-term Results of Total Knee Arthroplasty in Octogenarian

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## Research Article

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# Abstract

*Background:* With increasing life expectancy and aging population, more octogenarians would benefit from total knee arthroplasty (TKA). The aim of this study is to evaluate the survivorship of TKA in octogenarian and their long-term outcomes.

*Methods:* This was a retrospective review of 67 patients aged above 80 years who had primary TKA performed between 2005-2013 at a single centre. A sex-matched younger cohort of 67 primary TKAs during the same time-period was recruited for control. 5- and 10-year survival was calculated. Pre- and peri-operative factors were collected and compared. Post-operative range of motion, Knee Society Score (KSS) and Function Score (KFS) were collected and compared. Rate of revision, infection, aseptic loosening and mortality was collected.

*Results:* The mean follow-up period was  $10.39 \pm 2.29$  years. The 5- and 10- year survival of octogenarian group was 85.1% and 54.6% respectively. Pre- and peri-operative factors between the octogenarian and control groups were comparable ( $p > 0.05$ ). Both groups showed improvement in range of motion, KSS and KFS post-operatively. Rate of revision, aseptic loosening and deep infection was 0% in octogenarian and 1.5% in control group.

*Conclusions:* TKA can be performed in patients with age above 80 years old with comparable post-op knee range, complication rate and long-term functional score. Advanced age should not be a limiting factor for TKA.

## Background

Osteoarthritis (OA) of the knee is a common disease globally. The lifetime risk of developing symptomatic knee OA is estimated to be up to 47%, which further increases after the age of 60[1]. Total knee arthroplasty (TKA) is effective treatment for treating patients with end-stage osteoarthritis of the knee[2–4]. In the US alone, more than 600,000 TKA were performed in 2010[5].

According to local published statistics in 2017, the elderly (age > 65) is expected to increase from 16% of the total population in 2016 to 29% by 2036[6]. This aging population are expected to present with symptomatic knee OA indicated for TKA. Due to increasing age and medical morbidities, TKAs in octogenarian have been shown to be associated with higher post-operative complications, mortality and longer length of stay in comparison with younger patients[7–9]. At the same time, patients aged 80 and over would still benefit greatly from the improved pain, function and quality of life. This has been well supported by current literature regarding short term benefit[10–15], however mid- to long-term results of TKA in octogenarian has been scarcely reported.

This study aims to compare the safety and outcomes of TKA in the octogenarian population.

## Methods

Ethics approval was obtained from the Research Ethics Review Board (CREC Ref. No. 2015.433). All methods in the study were carried out in accordance with the Helsinki guidelines and declaration or any other relevant guidelines.

This was a retrospective review of all patients aged 80 years old and above who underwent elective TKA between December 2005 and August 2013 in the orthopaedic unit of a tertiary hospital. The data for this study were retrieved from the electronic record system from the hospital. Pre-operative, peri-operative and post-operative factors were collected. A sex-matched group of patients aged 70–80 years, from a total of 950 TKAs performed within the same period, was selected as a comparison.

Pre-operative factors included comorbidities, indications of surgery (e.g. OA, rheumatoid arthritis, post-traumatic arthritis, etc), Knee Society Score (KSS) and Functional Score (KFS), age at time of surgery, history of knee surgery, steroid usage, smoking status, pre-op knee range and fixed flexion deformity. Peri-operative factors included the type of anaesthesia, American Society of Anaesthesiologists (ASA) grading, the model of implant, duration of surgery, length of stay (LOS), ambulatory status on discharge and discharge status (direct home or to convalescence). Post-operative factors included implant survivorship, KSS and KFS, range of motion, Charnley Functional Score[16], as well as rate of revision, infection or aseptic loosening. Intra- and post-operative complications were also recorded and divided into major and minor complications. Major complications included deep infection of implant, vascular injury, myocardial infarction, fast atrial fibrillation, stroke, pulmonary embolism and cardiac arrest. Minor complications included superficial wound infection, acute retention of urine, deep vein thrombosis, pneumonia and urinary tract infection. The primary outcome is the survivorship of TKA in this age group. Complications such as aseptic loosening, infection and revision TKA was considered a failure of TKA. Secondary outcomes include the functional benefit and rate of complication following TKA.

## Statistical analysis

Pre-, peri- and post-operative factors between the above-80 and the control group were compared using Student's t-test. Pre- and post-operative functional score, flexion range were compared using paired t-test. Kaplan-Meier survival analysis was done comparing the above-80 and control groups. Revision TKA was considered as the end-point. Patient mortality was also an end-point to investigate the viability, longevity, and success of TKA in their 80's. Data analysis was performed using IBM SPSS 26.0 (Armonk, New York). A p-value of  $\leq 0.05$  was considered statistically significant.

## Results

A total of 67 patients above aged 80 years had TKA performed, with 23 of them being male (34.3%). This ratio was the same in our sex-matched control group. All patients in our study underwent TKA due to primary osteoarthritis of the knee, except one patient in the 70–80 group which was due to psoriatic arthropathy. Mean age of the octogenarian group was  $82.49 \pm 1.97$  (1SD) years. Mean age of the control group was  $73.90 \pm 2.78$  (1SD) years. Overall mean follow-up period was  $10.39 \pm 2.29$  years (95% CI:

10.00-10.78). Mean follow-up for the octogenarian group and control group was  $10.43 \pm 2.41$  years (95% CI: 9.85–11.01) and  $10.35 \pm 2.18$  years (95% CI: 9.83–10.88) respectively. Pre-operative factors such as sex distribution, laterality, body weight, steroid usage, smoking status, indication of surgery, previous knee surgery, pre-op deformity, range of motion did not show statistical difference ( $p > 0.05$ )(Table 1).

Table 1  
Pre-operative factors between the two groups of patients

| <b>Baseline characteristics</b> | <b>Age ≥ 80<br/>(N = 67)</b> | <b>Age 70–80<br/>(N = 67)</b> | <b>P value</b> |
|---------------------------------|------------------------------|-------------------------------|----------------|
| Age at surgery                  |                              |                               |                |
| Mean ± SD                       | 82.49 ± 1.97                 | 73.90 ± 2.78                  | < 0.01         |
| (Range)                         | (80.10, 89.07)               | (70.00, 79.00)                |                |
| Median                          | 82.00                        | 74.00                         |                |
| Sex                             |                              |                               | 1.00           |
| Male                            | 44 (65.7%)                   | 44 (65.7%)                    |                |
| Female                          | 23 (34.3%)                   | 23 (34.3%)                    |                |
| Side                            |                              |                               | 0.39           |
| Left                            | 38 (56.7%)                   | 32 (47.8%)                    |                |
| Right                           | 29 (43.3%)                   | 35 (52.2%)                    |                |
| Body weight (kg)                |                              |                               | 0.23           |
| Mean ± SD                       | 61.68 ± 8.80                 | 63.97 ± 10.50                 |                |
| (Range)                         | (46.60, 83.00)               | (38.00, 88.00)                |                |
| Median                          | 60.00                        | 64.20                         |                |
| Steroid user                    |                              |                               | 1.00           |
| Yes                             | 2 (3.0%)                     | 2 (3.0%)                      |                |
| No                              | 65 (97.0%)                   | 65 (97.0%)                    |                |
| Smoker                          |                              |                               | 0.62           |
| Yes                             | 1 (1.5%)                     | 3 (4.5%)                      |                |
| No                              | 66 (98.5%)                   | 64 (95.5%)                    |                |
| Diagnosis                       |                              |                               | 1.00           |
| Osteoarthritis                  | 67 (100.0%)                  | 69 (98.6%)                    |                |
| Other                           | 0 (0.0%)                     | 1 (1.4%)                      |                |
| Previous knee operation         |                              |                               | 1.00           |
| Yes                             | 0 (0.0%)                     | 1 (1.5%)                      |                |
| No                              | 67 (100.0%)                  | 66 (98.5%)                    |                |

| <b>Baseline characteristics</b> | <b>Age ≥ 80<br/>(N = 67)</b> | <b>Age 70–80<br/>(N = 67)</b> | <b>P value</b> |
|---------------------------------|------------------------------|-------------------------------|----------------|
| Pre-op deformity                |                              |                               | 0.49           |
| Varus                           | 61 (91.0%)                   | 64 (95.5%)                    |                |
| Valgus                          | 6 (9.0%)                     | 3 (4.5%)                      |                |
| Degree of deformity             |                              |                               | 0.88           |
| Mean ± SD                       | 11.31 ± 4.78                 | 11.44 ± 4.87                  |                |
| (Range)                         | (5, 25)                      | (5, 25)                       |                |
| Median                          | 10.00                        | 10.00                         |                |
| Pre-op flexion Contracture      |                              |                               | 0.11           |
| Mean ± SD                       | 10.37 ± 7.03                 | 8.65 ± 5.28                   |                |
| (Range)                         | (0, 30)                      | (0, 26)                       |                |
| Median                          | 10.00                        | 10.00                         |                |

Mean surgical time was lower for the octogenarian group ( $97.21 \pm 18.75$ min) in comparison with the control group ( $104.61 \pm 18.64$ min,  $p = 0.02$ ). (Table 2) Mean LOS was comparable in both groups, with  $9.55 \pm 3.28$  days (above-80 group) vs  $9.23 \pm 3.19$  days (control group) ( $p = 0.56$ ). Peri-operative factors such as type of anaesthesia, model of implant, post-op haemoglobin (Hb) drop, post-op complication, discharge status and post-op Charnley classification did not show statistical difference ( $p > 0.05$ ). Both groups had a majority of ASA grade 2, however more of the octogenarian group had ASA grading of 3 (26.7% vs 10.4%), which did not reach statistical significance ( $p = 0.072$ ). Referring to the local statistics report on mortality in year 2018, the age-specific mortality rate of population at age  $\geq 80$  was 14.3% (or 143.3 deaths per 1000 population). Mortality rate for the octogenarian group was higher than the control group (43.3% vs 19.4% respectively,  $p < 0.01$ ). The deceased patients had a mean survival of 6.30 years (octogenarian group) vs 6.38 years (control group) post-operatively. The most common cause of death for both octogenarian and control groups was pneumonia (41.4% and 30.8% respectively) which was unrelated to the index operation. One patient in the control group suffered from cardiac arrest on post-op day 12; otherwise all patients were either discharged home or to convalescence hospital. 3 patients (4.5%) in the octogenarian group suffered from major complications in comparison to 5 from the control group (7.5%). (Table 3) Overall complication rate was 32.8% in octogenarian versus 25.4% in control group. Major complications included deep implant infection, vascular injury, myocardial infarction, fast atrial fibrillation, stroke and pulmonary embolism, which was 4.5% vs 7.5% (octogenarian vs control). Minor complications included superficial wound infection, acute retention of urine, deep vein thrombosis, pneumonia and urinary tract infection, which was 28.3% vs 19.4% (octogenarian vs control). All complications, major and minor, were charted in Table 3. The most common complication for both

octogenarian and control groups was deep vein thrombosis (16.4% and 14.9% respectively). Rate of revision due to infection or aseptic loosening was 0% and 1.5%.

Table 2  
Intra- and post-operative outcomes

| Intra- and post-operative outcomes | Age ≥ 80<br>(N = 67) | Age 70–80<br>(N = 70) | P value |
|------------------------------------|----------------------|-----------------------|---------|
| Anesthesia                         |                      |                       | 0.545   |
| CSE                                | 22                   | 17                    |         |
| GA                                 | 6                    | 10                    |         |
| GA + Epidural                      | 0                    | 1                     |         |
| GA + Femoral nerve block           | 2                    | 1                     |         |
| SA                                 | 36                   | 35                    |         |
| SA + Femoral nerve block           | 0                    | 2                     |         |
| Unknown                            | 1                    | 1                     |         |
| ASA                                |                      |                       | 0.072   |
| 1                                  | 3                    | 4                     |         |
| 2                                  | 35                   | 47                    |         |
| 3                                  | 18                   | 7                     |         |
| 4                                  | 1                    | 2                     |         |
| Model of implant                   |                      |                       | 0.538   |
| Genesis II                         | 6                    | 6                     |         |
| LCCK                               | 2                    | 0                     |         |
| Legacy                             | 38                   | 40                    |         |
| LPS-Flex                           | 0                    | 1                     |         |
| PFC                                | 11                   | 14                    |         |
| Scorpio                            | 1                    | 2                     |         |
| TC3                                | 1                    | 1                     |         |
| Triathlon                          | 8                    | 3                     |         |
| Tourniquet Time (mins)             | 74.96 ± 17.14        | 83.06 ± 17.56         | 0.01    |
| Surgical time (mins)               | 97.21 ± 18.75        | 104.61 ± 18.64        | 0.02    |
| Post-op Hb drop (g/dL)             | 3.71 ± 1.24          | 3.95 ± 1.16           | 0.25    |
| Length of stay (days)              | 9.55 ± 3.28          | 9.23 ± 3.19           | 0.56    |

| <b>Intra- and post-operative outcomes</b>  | <b>Age ≥ 80<br/>(N = 67)</b> | <b>Age 70–80<br/>(N = 70)</b> | <b>P value</b> |
|--|------------------------------|-------------------------------|----------------|
| Post-op complication                       |                              |                               | 0.440          |
| Yes  | 45                           | 50                            |                |
| No   | 22                           | 17                            |                |
| Discharge status                           |                              |                               | 0.779          |
| Direct home                                | 8                            | 6                             |                |
| Convalescent                               | 59                           | 61                            |                |
| Post-op Charnley Functional Classification |                              |                               | 0.693          |
| A  | 41                           | 43                            |                |
| B  | 18                           | 18                            |                |
| C  | 8                            | 5                             |                |
| Revision                                   |                              |                               | 1.000          |
| Yes  | 0                            | 1                             |                |
| No   | 67                           | 66                            |                |
| Infection                                  |                              |                               | 1.000          |
| Yes  | 0                            | 1                             |                |
| No   | 67                           | 66                            |                |
| Aseptic loosening                          |                              |                               |                |
| No   | 67                           | 67                            | -              |
| Last seen status                           |                              |                               |                |
| Alive                                      | 38 (56.7%)                   | 54 (80.6%)                    | < 0.01         |
| Deceased                                   | 29 (43.3%)                   | 13 (19.4%)                    |                |

Table 3  
Post-op complications.

| Post-op complications     |                             | Age ≥ 80   | Age 70–80  |
|---------------------------|-----------------------------|------------|------------|
|                           |                             | Number (%) | Number (%) |
| Major complications       | Deep implant infection      | 0 (0)      | 1 (1.5%)   |
|                           | Vascular injury             | 0 (0)      | 1 (1.5%)   |
|                           | Myocardial infarction       | 1 (1.5%)   | 0 (0)      |
|                           | Fast atrial fibrillation    | 1 (1.5%)   | 1 (1.5%)   |
|                           | Stroke                      | 1 (1.5%)   | 0 (0)      |
|                           | Pulmonary embolism          | 0 (0)      | 1 (1.5%)   |
|                           | Cardiac arrest              | 0 (0)      | 1 (1.5%)   |
| Minor complications       | Superficial wound infection | 2 (3.0%)   | 0 (0)      |
|                           | Acute retention of urine    | 2 (3.0%)   | 2 (3.0%)   |
|                           | Deep vein thrombosis        | 11 (16.4%) | 10 (14.9%) |
|                           | Pneumonia                   | 3 (4.5%)   | 1 (1.5%)   |
|                           | Urinary tract infection     | 1 (1.5%)   | 0 (0)      |
| Major complication rate   |                             | 3 (4.5%)   | 5 (7.5%)   |
| Minor complication rate   |                             | 19 (28.3%) | 13 (19.4%) |
| Overall complication rate |                             | 22 (32.8%) | 17 (25.4%) |

There was no difference between the pre-op flexion range and Knee Society Score (KSS) between the two groups. The control group had a higher pre-op Function Score (KFS) which was statistically significant ( $p < 0.01$ ). (Table 4) Both groups showed improvement in knee flexion range, KSS and KFS post-operatively. (Table 5) There was an overall improvement in KFS of the above-80 group, however it was not statistically significant ( $p = 0.16$ ).

Table 4  
Functional outcomes between the octogenarian and control groups.

|   | Pre-op        |               |         | Post-op        |                |         |
|---|---------------|---------------|---------|----------------|----------------|---------|
|   | Age ≥ 80      | Age 70–80     | P value | Age ≥ 80       | Age 70–80      | P value |
| Flexion range (± SD)                                      | 91.34 ± 15.07 | 93.08 ± 15.10 | 0.50    | 104.63 ± 14.65 | 105.92 ± 11.77 | 0.59    |
| KSS (± SD)  | 34.48 ± 12.73 | 34.75 ± 10.86 | 0.90    | 94.22 ± 6.70   | 94.62 ± 6.06   | 0.73    |
| KFS (± SD)  | 42.39 ± 17.80 | 50.71 ± 16.18 | 0.01    | 46.46 ± 27.82  | 61.00 ± 23.15  | < 0.01  |
| KSS: Knee Society Score, KFS: Knee Society Function Score |               |               |         |                |                |         |
| *Student's T-test   |               |               |         |                |                |         |

Table 5  
Comparison of functional outcomes pre- and post-operatively.

|   | Age ≥ 80      |                | P value | Age 70–80     |                | P value |
|---|---------------|----------------|---------|---------------|----------------|---------|
|   | Pre-op        | Post-op        |         | Pre-op        | Post-op        |         |
| Flexion range (± SD)                                      | 91.34 ± 15.07 | 104.63 ± 14.65 | < 0.01  | 93.08 ± 15.10 | 105.92 ± 11.77 | < 0.01  |
| KSS (± SD)  | 34.48 ± 12.73 | 94.22 ± 6.70   | < 0.01  | 34.75 ± 10.86 | 94.62 ± 6.06   | < 0.01  |
| KFS (± SD)  | 42.39 ± 17.80 | 46.46 ± 27.82  | 0.21    | 50.71 ± 16.18 | 61.00 ± 23.15  | < 0.01  |
| KSS: Knee Society Score, KFS: Knee Society Function Score |               |                |         |               |                |         |
| *Paired T-test  |               |                |         |               |                |         |

Five-year and 10-year survival of the above-80 group was 86.6% and 55.9% respectively. (Table 6, Fig. 1) In comparison, the 5- and 10-year survival of the control group was 92.5% and 81.4% respectively. This was statistically significant with  $p < 0.01$ . 5-year and 10-year implant survival was 1.000 and 1.000 in the octogenarian group; the control group had 5- and 10-year implant survival of 0.985 and 0.985. (Table 7, Fig. 2) This difference was not statistically significant with  $p = 0.32$ .

Table 6  
Patient survival rate and standard error (SE) of the two groups using Kaplan-Meier product limit method.

| Years since TKR | Age ≥ 80 |       | Age 70–80 |       | Log rank | P value |
|-----------------|----------|-------|-----------|-------|----------|---------|
|                 | Estimate | SE    | Estimate  | SE    |          |         |
| 5               | 0.851    | 0.044 | 0.953     | 0.026 | 20.87    | < 0.01  |
| 10              | 0.546    | 0.069 | 0.913     | 0.037 |          |         |

Table 7  
Implant survival rate and standard error (SE) of the two groups using Kaplan-Meier product limit method.

| Implant survival (Years) | Age ≥ 80 |    | Age 70–80 |       | Log rank | P value |
|--------------------------|----------|----|-----------|-------|----------|---------|
|                          | Estimate | SE | Estimate  | SE    |          |         |
| 5                        | 1.000    | -  | 0.985     | 0.015 | 1.000    | 0.32    |
| 10                       | 1.000    | -  | 0.985     | 0.015 |          |         |

## Discussion

TKAs are a common, safe and effective procedure. However, some healthcare providers may be averse to offer TKAs in patients aged above 80 due to concerns of higher risk of surgery as well as patient survivorship. Many studies in different specialties have shown the pervasiveness of ageism in healthcare systems around the world resulting in poorer patient outcomes[17–21]. With better healthcare and longer average life expectancy[22], we can anticipate more and more healthy and active elderly who would benefit from the improved function that TKAs can provide. Here we have shown that TKAs are safe and effective in the octogenarian population with comparable rate of revision and post-operative outcome. To the authors' best knowledge, this was the first study to investigate the long-term results of TKA in octogenarian.

In terms of implant survival, our study correlates with Klasan *et al.*, who looked at the medium-term outcomes of TKAs in octogenarians in Australia[23]. Implant survivorship at 10 years was reported at 99.5%, and patient survivorship was 26% at 10 years; mean follow-up was 7.76 years. Joshi[15] reported a 10-year patient survival of 34% in octogenarian TKAs in 2003. Our study observed a 10-year implant and patient survivorship of 100% and 54.6% respectively. As expected, the elderly enjoyed excellent implant survival but had poorer patient survival. The difference in patient survival between our study and Klasan's may be explained by our higher life expectancy than Australia[24].

Tay *et al.*[25] found the 2-year revision rate was higher in octogenarians (2.9% vs 1.4%), but this was not statistically significant ( $p = 0.31$ ). Klasan[23] reported a revision rate of 0.46% (versus 1.55% in younger patients,  $p = 0.51$ ) with mean follow-up of 7.76 years. The lower rate of revision is likely due to lower

functional demand and higher threshold for performing revision arthroplasty in the elderly. In our study, the rate of revision was comparable to the younger cohort; only 1 patient in the control group required revision TKA, which may be due to smaller sample size.

Multiple studies have shown a correlation between advanced age with increasing LOS[25, 26]. Tay *et al.* reported a mean LOS of 6.3 vs 5.4 days in octogenarian vs younger cohort. Austin *et al.* reported a mean LOS of 3.30 vs 2.91 days, with 37% requiring facility discharge. In comparison, our LOS was  $9.55 \pm 3.28$  vs  $9.23 \pm 3.19$  days (octogenarian vs control), with 87% discharged to convalescent hospital. This is likely due to old practice; with introduction of newer surgical practice and accelerated rehabilitation protocols[27], most our patients currently have shorter length of stay and are discharged home directly.

Yohe *et al.* studied the complication rate of octogenarians according to the American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) database in USA[28]. Rate of major complications such as stroke, myocardial infarction, sepsis and revision surgery was found to be 3.5%, with overall rate of revision 1.2%. 4.7% patients presented with unplanned readmissions within 30 days. In comparison, our rate of major complications in octogenarian was 4.5%, and revision rate was 0%. The slightly higher complication rate and difference in rate of revision may be due to small sample size or overall low TKA volume at our hospital. We report a high minor complication rate in our study (28.3%), with a majority due to deep vein thrombosis (DVT). This is due to the lack of modern multi-modal DVT prophylaxis such as early mobilisation, thromboembolism-deterrent stockings, sequential compression devices and direct oral anticoagulants which are now routine in our unit. Overall mortality rate in Yohe's study was found to be 0.3%, which was increased in patients with dependent functional status and ASA > 2 (OR 8.94 and 6.11 respectively). This was comparable with our findings of 0%.

Cher *et al.* studied the functional scoring between octogenarians and younger patients in TKA at 6 and 24 months[29]. Both groups showed statistical improvement in KSS and KFS post-operatively. In the octogenarian group, mean KSS improved from 36.77 to 84.44 ( $p < 0.05$ ), while mean KFS improved from 39.50 to 55.77 ( $p < 0.05$ ). In our study, mean KSS in octogenarian improved from 34.48 to 94.22 ( $p < 0.01$ ) which was comparable. This improvement was maintained during the lifetime of the prosthesis as well as the patient. KFS in our study was not significantly improved, this may be due to deterioration in our patients' overall ambulatory status with longer follow-up and increasing age.

There are limitations in our study. This study was retrospective in nature; octogenarians with poor pre-morbid status and deemed surgically unfit would naturally not be included. There would also be inherent bias from healthcare providers and relatives to opt for a more conservative management in marginal patients. Using revision as an end-point for TKA survivorship in these patients may therefore underestimate the true figure. In this study, our control group was chosen to be aged between 70 to 80. This was intentionally done to provide a more comparable cohort to the above-80 group. We would anticipate a larger difference in pre-operative functional score, post-op improvement as well as complication rate with a control group that included all ages. Our moderate sample size of 67 patients at a single centre may also affect the power of our study. This study was performed more than a decade

ago; evolving surgical methods, different surgeons as well as introduction of multi-disciplinary approach to accelerated TKA rehabilitation may also introduce heterogeneity between earlier and later cases in our study.

Here we have shown that TKA in octogenarian has similar complication rate and functional outcome compared to a younger age group. Despite the higher ASA grading overall, post-operative complications were comparable to those aged between 70–80 years old. While there was a lower patient survivorship in the elderly group due to age difference, implant survivorship was comparable. Function score remains poor in octogenarian without significant difference in comparison to the younger cohort; this is to be expected as they often have impaired muscle strength, coordination and balance. However, patients are still able to benefit from TKA with improved knee range of movement and pain which is reflected in KSS. Clear surgical objective, addressing patients' concern and expectation is paramount in order to achieve good outcome following TKA.

## Conclusions

TKA can be performed in patients with age above 80 years old with comparable post-op knee range, complication rate and long-term functional score. Advanced age should not be a limiting factor for TKA.

## Declarations

Ethics approval and consent to participate:

Ethical approval was obtained from the ethics review board of the Joint NTEC/CUHK Ethics Committee (Research Ethics Committee approval number: 2015.433).

Written informed consent was obtained from every participant for informed consent.

Informed consent was obtained from legally authorized representatives of the deceased patients.

Consent for publication:

Written informed consent was obtained from every participant.

Availability of data and materials:

The datasets used and/or analysed during the current study are available from the corresponding author upon request.

Competing interests:

The authors declare that they have no competing interests.

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#### Author's contributions

Kevin Ki Wai Ho, Kwong-Yin Chung, Kwok-Hing Chiu and Rex Wang-Fung Mak designed the research, collected and assembled the data, and wrote the paper. Wai-Wang Chau analysed and interpreted the data and contributed to the writing of the paper. All authors took part in the writing and final editing of the manuscript. All authors have been given a copy of the manuscript, all have approved the final version of the manuscript, and all are prepared to take public responsibility for the work and share responsibility and accountability for the results.

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## Figures

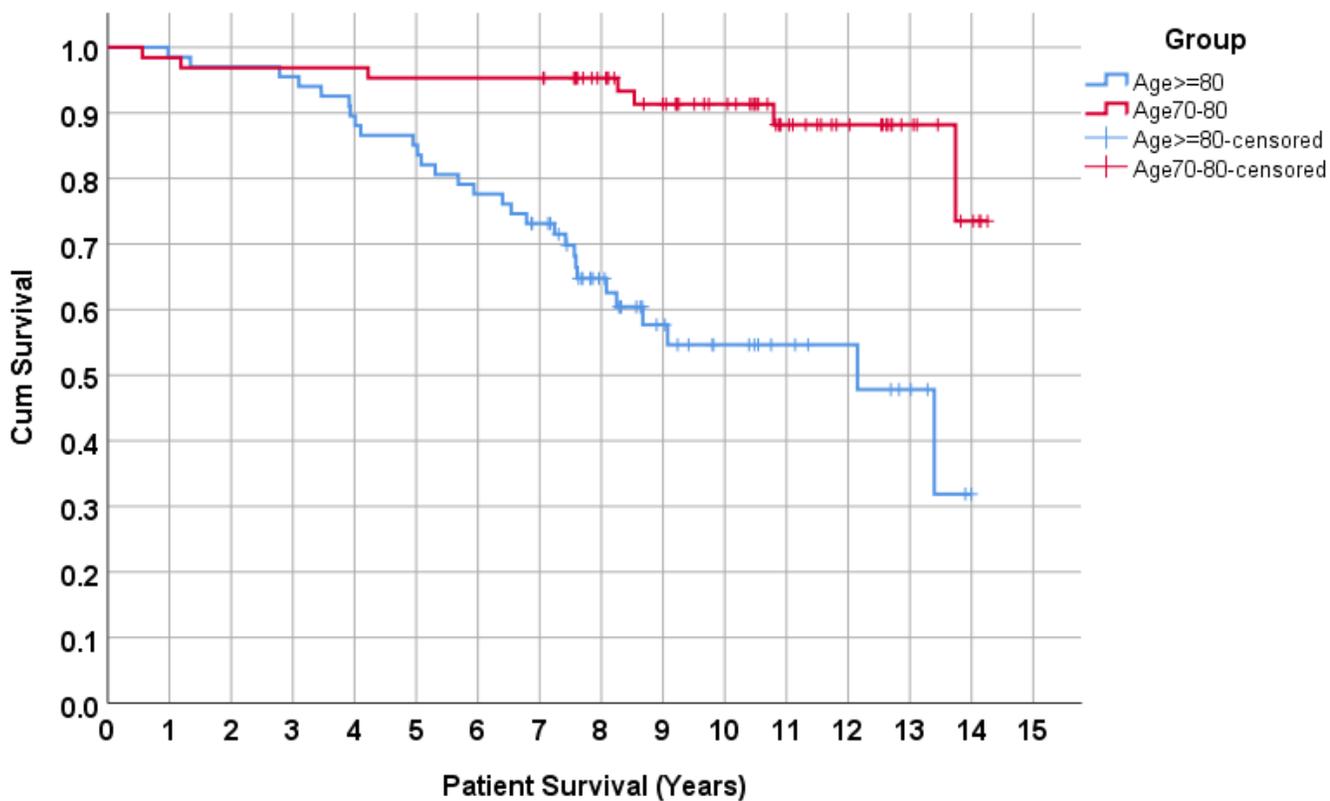


Figure 1

Kaplan-Meier curve of patient survival time in above-80 and control groups.

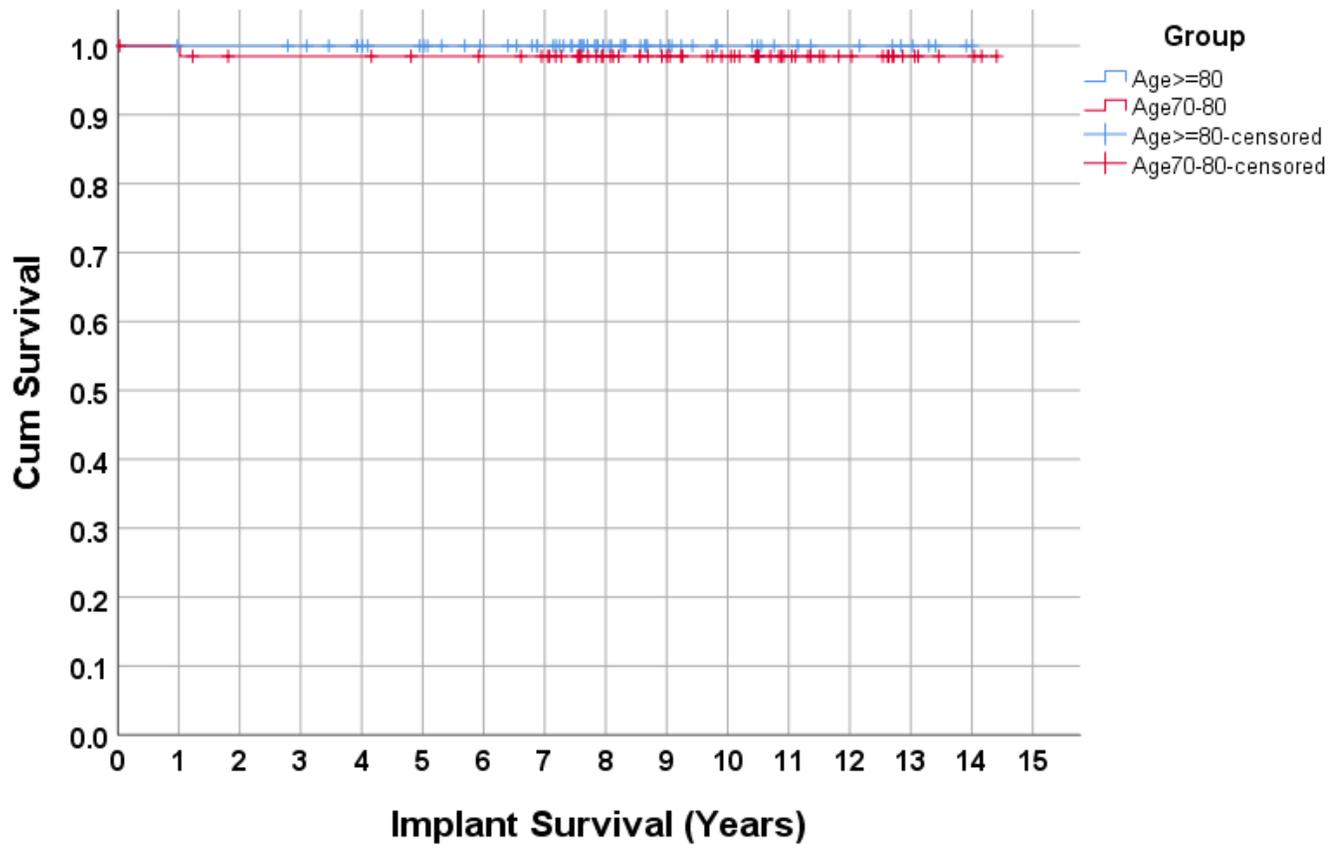


Figure 2

Kaplan-Meier curve of implant survival time in above-80 and control groups.