2- to 9-year outcome of stemmed total knee arthroplasty

Similar failure rates in patients when used primary or as a revision

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Submitted 2014-02-14. Accepted 2014-06-20

Background and purpose — There is an increase in demand for primary and revision total knee joint procedures. We studied implant survival and functional outcome of patients operated with a constrained condylar knee (CCK) or a rotating hinge implant (RH) as a primary or a revision total knee arthoplasty (TKA).

Patients and methods — We evaluated clinically and radiographically 65 surgical procedures with a mean follow-up time of 5 (2–9) years (40 CCK and 25 RH). There were 24 primary TKAs—due to instability—and 41 revision TKAs, mostly due to aseptic loosening. Mean age at the index operation was 68 (31–88) years.

Results — Overall, there were 12 failures, including 8 reoperations due to deep infection. The overall 5-year survival rate with reoperation as the endpoint was 82% (95% CI: 72–99). Radiolucent lines on either the femoral or the tibial side were seen in 36 cases. When comparing the cases that were operated as a primary TKA or as a revision TKA, function, health-related quality of life, and survival were similar. However, after primary TKA the patients generally had less pain and a higher proportion of patients were very satisfied or satisfied.

Interpretation — Although a high rate of severe complications was observed, most patients improved in function after surgery regardless of whether it was a primary or a revision TKA. We found narrow radiolucent lines—mainly on the tibial side—in nearly half of the cases, but none of the implants were loose radiographically. Overall patient satisfaction and health-related quality of life were high, and a minority had problems with persistent pain.

There will be an increase in demand for primary and revision total knee joint arthroplasties over the coming decades (Kurtz et al. 2007, Hossain et al. 2010). The function of the soft-tissue envelope and possible bone deficiency guide implant choice. Revision implants are used in patients with severe valgus-varus instability and/or increased laxity in flexion gap (Hossain et al. 2010). There are constrained condylar prostheses (CCK) and linked rotating hinge (RH) designs. In the majority of cases, these designs are saved for revision surgery, but they may be used in primary TKA as well, especially if severe deformity or ligament instability is present (Petrou et al. 2004, Hossain et al. 2010).

The main purpose of this retrospective study was to gain information on implant survival and functional outcome in 65 consecutive procedures using stabilizing TKAs with stemmed components (CCKs and RHs). Secondary outcome measures were complication rate, patient satisfaction, health-related quality of life, and radiographic results. We also wanted to determine whether there were any differences in patient outcome when these implants were used as a primary knee replacement or as a revision total knee replacement.

Patients and methods

In this retrospective study, we evaluated 65 consecutive surgical procedures (in 63 patients) that were performed with stemmed stabilizing TKAs over 5 years in 2 hospitals in Stockholm (Karolinska University Hospital and Capio St. Görans Hospital). 12 patients underwent reoperations, includ-

DOI 10.3109/17453674.2014.962411

ing 4 in which the prostheses were removed. Not included in the analysis were 11 patients who had died during follow-up and 1 patient who was lost to follow-up. Cement was used for all components except for the stemmed portion and the metal metaphyseal sleeves when used (hybrid fixation) (Agarwal et al. 2013). Uncemented fixation of the stems and sleeves was performed in the meta-diaphyseal bone (press-fit). The mean follow-up time was 5 (2–9) years.

Data collected included demographic information, primary diagnosis, and indication for surgery. The visual analog scale (VAS) (0–10, where 0 = no pain) was used to document pain at rest and movement. Moreover, clinical evaluation included documentation of BMI, range of motion (ROM), knee stability, and patellar tracking. In addition, both the KOOS (with 100 indicating no symptoms and 0 indicating extreme symptoms) (Roos and Lohmander 2003) and the EuroQol (EQ-5D) (0–1, where 1 = full health) (Brooks 1996) were used.

We asked the patients at the latest follow-up if they were very satisfied, satisfied, or unsatisfied with the result. Moreover, we asked if there had been any changes concerning the use of walking aids or walking distance since the index surgery. Anterior-posterior and lateral radiographs of the knee were assessed by 3 observers. Bone defects of the tibia and femur at the index surgery were classified using the Anderson Orthopaedic Research Institute classification (Engh and Ammeen 1999). The Knee Society rating system was used regarding the presence of radiolucent lines at follow-up (Ewald 1989). Skyline patellar radiographs were compared postoperatively and at follow-up. Patellar thickness was subjectively assessed as being the same, 50–100%, or < 50%. The canal-filling ratio (CFR) was determined by dividing the stem diameter at the stem tip by the endosteal diameter at the location of the stem tip. Canal-filling stems were defined as stems with a CFR of ≥ 0.85 (Parsley et al. 2003).

Index surgery (Table 1)

Mean age at the index surgery was 68 years when operated with either a primary stemmed TKA (n = 24) or a revision stemmed knee replacement (n = 41). Primary osteoarthritis was diagnosed in the majority of the patients in both groups. The predominant indication for surgery was instability when operated with a primary stemmed TKA and aseptic loosening when operated with a secondary stemmed TKA. For those patients, who were operated with a secondary stemmed TKA, the mean time that had passed between the primary TKA and the revision was 6 (SD 5) years.

Implant choice was influenced by the integrity of the surrounding soft-tissue structures providing stability, and the bone defects. A stemmed CCK was used in 40 of all cases (PFC Sigma TC3 Revision Knee System, DePuy, n = 29; Triathlon TS Knee Replacement System, Stryker, n = 10; Duracon Total Stabilizer Revision System, Stryker, n = 1) and a stemmed RH implant in 25 of the cases (S-ROM Noiles Rotating Hinge Revision Knee System, DePuy). The 3 different types of CCK designs are similar. However, porous-coated metal metaphyseal sleeves are only available for the TC3 and the S-ROM prostheses (Agarwal et al. 2013). In both the tibia and the femur, the cementless metal sleeves were used in 7/24 of the primary cases and 17/41 of the revision cases. There were no significant differences in stem length and stem width between the 2 groups. Patients with a femoral sleeve had significantly shorter stems (mean 108 (SD 19) mm) than patients without a femoral sleeve (mean 136 (SD 22) mm) (p < 0.001).

Table 1. Patient characteristics at index surgery

	All	Primary	Revision	p-value
Surgical procedures	65	24	41	
Patients	63	23	40	
M / F	15 / 48	5 / 18	10 / 30	
Mean age (SD)	68 (12)	68 (13)	68 (11)	0.7
BMI, kg/m2 (SD)	29 (5)	30 (5)	29 (5)	0.2
Primary diagnosis				
Primary osteoarthritis	42	10	32	
Secondary osteoarthritis	20	12	8	
Rheumatic disorder	13	6	7	
Posttraumatic	7	6	1	
Other	3	2	1	
Main indication for surgery				
Aseptic loosening	23	-	23	
Instability	30	24	6	
Infection	10	-	10	
Other	2	-	2	
Type of primary prosthesis before index surgery				
Posterior cruciate-retaining	36	-	36	
Posterior-stabilized	4	-	4	
Unicompartmental	1	-	1	
Cemented / Uncemented	40 / 1	-	40 / 1	
Type of stemmed TKA at index surgery				0.2
Constrained condylar knee	40	17	23	
Rotating-hinge knee	25	7	18	
Tibial component				
Sleeve	24	7	17	
Stem length, mm (SD)	96 (22)	94 (23)	98 (21)	0.2
Stem width, mm (SD)	14 (3)	15 (3)	14 (3)	0.1
Femoral component				
Sleeve	24	7	17	
Stem length, mm (SD)	126 (25)	129 (24)	124 (25)	0.4
Stem width, mm (SD)	16 (3)	16 (3)	16 (2)	0.3
Patella				
Prosthesis	5	-	5 [a]	
Lateral release	18	11	7	
Quadriceps snip	4	1	3	
Tuberositas tibiae osteotomy	3	1	2	
Classification of bone defects				
Tibia				0.2
0	2	2	-	
Type I	20	6	14	
Type II	28	12	16	
Type III	15	4	11	
Femur				0.2
0	2	2	-	
Type I	19	7	12	
Type II	27	8	19	
Type III	17	7	10	

[a] 1 patellar prosthesis from the original TKA was left in place.

Table 2. Patient characteristics at follow-up

	All	Primary	Revision	p-value
Surgical procedures	61 [a]	22	39	
Pain, VAS (SD)				
Rest	1.6 (2.4)	0.7 (1.9)	2 (2.5)	0.03
Movement	3.3 (3.3)	1.7 (2.5)	4.2 (3.4)	0.009
BMI, kg/m^2 (SD)	29 (6)	30 (7)	29 (6)	0.9
Range of motion, degrees (SD)	102 (21)	107 (12)	100 (24)	0.5
Medial-lateral stability				
Stable	51	18	33	
Unstable [+]	6	2	4	
Missing	4	2	2	
Patella				0.03
Tracking	46	20	26	
Subluxation	10	-	10	
Dislocation	2	-	2	
Missing	3	2	1	
KOOS (SD)				
Pain	64 (28)	76 (24)	58 (28)	0.02
Other symptoms	73 (23)	83 (18)	67 (24)	0.02
Function in daily living	55 (28)	57 (27)	54 (29)	0.7
Function in sports and recreation	14 (30)	22 (35)	10 (17)	0.3
Knee-related quality of life	51 (32)	61 (26)	47 (34)	0.1
EQ-5D (SD)	0.4 (0.4)	0.5 (0.5)	0.4 (0.4)	0.7
Outcome				0.003
Very satisfied or satisfied	47	22	25	
Dissatisfied	12	-	12	
Missing	2	-	2	
Walking aids, clinical improvement	24	8	16	0.7
Walking distance, clinical improvement	25	10	15	0.6

[a] Not included are 4 cases in which the prosthesis was removed during follow-up.

On the tibial side, patients with a sleeve had significantly longer stems (mean 103 (SD 16) mm) than patients without a sleeve (mean 93 (SD 24) mm) (p = 0.05).

There were only 2 patients without any bone defects when operated with a primary stemmed TKA. All secondary cases had bone loss with an even distribution between types I, II, and III.

Statistics

Quantitative results are reported as mean with standard deviation (SD). Kaplan-Meier survival analysis was performed with reoperation as the endpoint. Life tables and survival functions with 95% confidence intervals (CIs) were calculated. Follow-up started on the day of the index operation and ended on the day of reoperation, death, or latest follow-up. The Wilcoxon signed-rank test was used to compare 2 related samples. The Mann-Whitney test was used for comparing data from 2 independent groups. Pearson's chi-squared test was chosen for observations on 2 variables, expressed in a contingency table. All statistical analyses were performed using the PASW statistics package version 18.

Ethics

The study was approved by the Regional Ethical Review Board in Stockholm (Dnr 2010/1584-31/1).

Results

Follow-up (Table 2)

For the entire group, the mean VAS for pain at rest was 1.6 (SD 2.4) and for motion it was 3.3 (3.3). Regarding motion, 30 patients located the pain in the relevant knee joint, 7 had pain in the knee and/or the lower leg, 4 had pain in the knee and/or the thigh, and 17 did not have any pain (missing n = 3). When operated in a primary situation, the patients complained about less pain both at rest and on movement, and a higher proportion of the patients were very satisfied or satisfied. A better outcome for the primary cases was also noted in the KOOS for pain and other symptoms. Patellar problems such as subluxation or dislocation were only seen in the revision cases.

Survival and failures (Table 3)

The overall 5-year survival rate with reoperation as the endpoint was 82% (CI 72–99). Altogether, there were 12 failures. 8 patients had deep infections: in 1 of these patients, the TKA was converted to a knee arthrodesis. However, the infection persisted and the leg was finally amputated. Another patient with a deep infection was later converted to a tumor prosthesis due to implant breakage. 2 other patients were revised in a 2-stage procedure.

Non-septic failures were as follows. 1 patient received a patellar component, in 1 patient a hematoma was evacuated, 1 patient was reoperated for quadriceps tendon rupture, 1 patient had an arthroscopic synovectomy due to local pain, and 1 patient had a periprosthetic fracture (which was operated with a plate osteosynthesis). Implant survival and failure rates were similar in the primary group and in the revision group.

Radiographs (Table 4)

Overall, radiolucent lines on the femoral side were seen in 16 cases and on the tibial side in 30 cases On the tibial side, radiolucent lines were mainly seen at the medial plateau. There were only 3 implants with radiolucent lines of grade III (> 2 mm). On the femoral side, the primary cases had propor-

Table 3. Survival and failures (n = 65 cases)

	All	Primary	Revision	p-value
5-year survival, %	82	80	83	0.9
95% CI	72–99	62–99	71–99	
Failures (reoperations)	12	4	8	0.8
Deep infection	8	2	6	
Other	4	2	2	

Table 4. Radiographic results for stemmed total knee arthroplasties at follow-up (n = 56 cases)

Radiolucent lines	0 mm	1 mm	2 mm	3 mm
Tibial component				
Anterior-posterior view				
Medial plateau	42	12	2	-
Lateral plateau	47	9	-	-
Medial stem	49	4	3	-
Lateral stem	50	4	1	1
Lateral view				
Anterior plateau	47	6	3	-
Posterior plateau	45	6	5	-
Femoral component				
Anterior-posterior view				
Medial stem	45	6	4	1
Lateral stem	45	5	6	-
Lateral view				
Shield	51	4	1	-
Anterior stem	46	6	3	1
Posterior stem	49	6	1	-

tionately fewer radiolucent lines (2/19) than the revision cases (14/37) (p = 0.03).

Patellar thickness at follow-up was unchanged in 42 cases, reduced by 50–100% in 6, and reduced by < 50% in 5 cases (missing n = 2). The mean canal-filling ratio was 0.84 (SD 0.08) for the tibia and 0.89 (SD 0.09) for the femur.

Discussion

The outcome in patients operated with CCK and RH with uncemented stems has generally been successful (Sheng et al. 2004, Peters et al. 2009, Hossain et al. 2010). Most of our patients were very satisfied or satisfied, which is in accordance with the experience of other authors (Sheng et al. 2005, Sheng et al. 2006a, Kim and Kim 2009, Gudnason et al. 2011). Patient satisfaction 1 year after primary TKA with conventional knee implants, assessed with a disease-specific questionnaire, is documented in the Swedish Knee Arthroplasty Register. As expected, our results were worse concerning activities of daily living, and sport and recreation function. However, the outcome for pain, other symptoms, and knee-related quality of life was similar (Roos and Lohmander 2003, SKAR 2012).

Aseptic loosening is the predominant mechanism of failure in patients with primary TKA (Schroer et al. 2013), which agrees with our findings. At follow-up, our patients had a mean ROM of about 100 degrees. Similar results were found in a meta-analysis, with a mean knee motion of 97 degrees after revision TKA (Sheng et al. 2004). We found favorable changes regarding the use of walking aids and walking distance, which has also been described by other authors (Kim and Kim 2009).

Patellar tracking was adequate in most of our cases. Still, 10 patients had a subluxation and 2 had a dislocation (all in the group with revision TKAs). Other authors have pointed out that patellar subluxation after revision TKA is associated with worse clinical outcome (Sheng et al. 2006b).

We found that suprisingly few patients complained about leg pain. "End of stem" pain has earlier been found to be common with stemmed tibial or femoral components, either cemented of uncemented (Barrack et al. 1999). Our findings may in part be due to the use of metal metaphyseal sleeves in one-third of the cases.

Our failure rate was higher than with data from 566 revision knee arthroplasties followed for 6 years on average (with 12% failure) (Suarez et al. 2008). Kim and Kim (2009) found a complication rate of 9% in 114 knees operated with a CCK prosthesis after 7 years of follow-up. A study of 1,356 patients on outcome after revision TKA found a complication rate that was similar to ours (19%). The most common complications were loosening (18%), instability (16%), infection (16%), and patellar failure (15%) (Sheng et al. 2004). Another report analyzing 499 revision TKAs described a failure rate of 18% (at 5-year follow-up), with infection as the major cause (Mortazavi et al. 2011).

Deep infection was the main indication for the index surgery in 10 of our 65 cases. Still, 8 out of 12 reoperations were due to deep infections, and there were another 5 patients with superficial wound infections who needed antibiotics. Our results concur with other studies that infection remains a major issue related to failure after surgery in revision TKAs (Sheng et al. 2004, Suarez et al. 2008, Peters et al. 2009, Mortazavi et al. 2011). A nationwide study of the Finnish Arthroplasty Registry analyzed 2,637 knees. The authors found that age > 70 years, revision > 5 years after the primary arthroplasty, and absence of patellar subluxation were positively associated with survival after revision TKA (Sheng et al. 2006b).

We found thin radiolucent lines in two-thirds of the cases on either the tibial or the femoral side, but only 3 cases with grade III. No major osteolysis was seen. In 2 other publications, the occurrence of radiolucent lines was reported to range between 23/71 knees and 28/39 knees after revision TKA without any reoperations due to aseptic loosening (Takahashi and Gustilo 1994, Sheng et al. 2006a). Other authors stated that they could not find any association between radiolucent lines and clinical results (Haas et al. 1995). Our results correspond to reports that have documented low rates of aseptic loosening as a cause of revision surgery (Bottner et al. 2006, Whiteside 2006). On the tibial side, thin radiolucent lines were mostly seen on the medially, which has been described previously (Sheng et al. 2005).

The limitations of the present study include the fact that there was only medium-term follow-up. Due to the retrospective nature of the study, we did not have any preoperative pain scores and other clinical data. The change in walking aids and walking distance was assessed at follow-up, thus involving a possible risk of recall bias. The patients were operated with different stemmed TKAs, but most knees with a CCK design

were operated with the TC3 prosthesis and all rotating hinge knees were operated with the S-ROM system. The absence of statistical significance concerning survival between the primary group and secondary group does not necessarily imply that there was no difference; i.e. the analysis was open to type-II error due to the limited number of cases available in the study group and the comparatively short follow-up. Not all observations are independent of each other (Bryant et al. 2006). In 2 patients with stemmed knee prostheses bilaterally, both sides were included in the analysis, as other studies have shown that this has no substantial effect on the risk of failure (Lie et al. 2004).

We conclude that although a high rate of severe complications was observed, most patients reported improved function after surgery. Implant survival was similar between those operated with a stemmed knee prosthesis as a primary operation and those who were operated as a revision (after failed primary TKA). Overall patient satisfaction and health-related quality of life were high and only a minority had problems with persistent pain.

The authors declare that they have no competing interests.

RJW: study design, data collection, data analysis, and writing and editing of the manucript. MT, JN, and MH: study design, data collection, and editing of the manuscript. AS: study design and editing of the manuscript.

We thank Dr Anders Herrlin and Dr Tom von Oelreich for their support with the present study.

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