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Pain Relief and Functional Improvement Remain 20 Years After Knee Arthroplasty

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Abstract

Background TKA provides demonstrable pain relief and improved health-related quality of life. Yet, a decline in physical function may occur over the long term despite the absence of implant-related problems.

Questions/purposes (1) Does pain relief diminish over 20 years after TKA? (2) Does function decline over 20 years in terms of Knee Society function, knee, and walking scores? And (3) what is the patient-reported activity level at most recent followup?

Patients and Methods We retrospectively identified 1471 patients with 1757 primary cruciate-retaining TKAs implanted between 1975 and 1989 and identified 128 living patients (8.7%) with 171 TKAs. Ninety-three patients were women. We determined Knee Society scores prospectively and UCLA scores retrospectively. Minimum followup was 20 years (average, 21.1 years; range, 20–27 years). Average age at last followup was 82.3 years (range, 45–103 years). Of the 128 patients, 66 (73 TKAs) died after 20-year followup.

Results Pain scores did not diminish over time (average, 49; range, 20–50). Average knee score was 78 (range, 39–97). Function, stair, and walking scores diminished over time. Average function score was 70 (range, 5–100), primarily due to an average stair score of 35 (range, 0–50); average walking score was 37 (range, 10–50). All but two patients (two TKAs) could negotiate stairs; 95 patients (124 TKAs) could walk at least five blocks; three patients (three TKAs) were housebound. Of the 62 patients still living (98 TKAs), the average UCLA activity score was 8.3 (range, 5–10).

Conclusions Although aging may cause a gradual decline in physical activity, an improved functional capacity and activity level continue 20 years or more after TKA.

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institutional approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

The long-term reports of TKA demonstrate prosthetic survival between 85% [25] and 99% [11] 20 years or more after the index arthroplasty [4, 6, 10, 11, 16, 21–23, 25]. These studies give evidence that, with the proper indications, surgical technique, and patient compliance, prosthetic durability may continue well into the third decade after implantation. An NIH Consensus Panel on TKA concluded substantial improvements in patient's pain, function, and overall health-related quality of life continue in up to 90% of patients, with 85% of patients being satisfied with the result of the arthroplasty [19]. These improvements may include

enhancements in physical, mental, and social aspects of patient's lives such as pain relief, mobility, activities of daily living, disability, and economic status [7, 12, 20].

Yet, a number of authors [3, 15, 17, 24, 29] have raised a concern that, with longer periods of followup, patient function may deteriorate, as demonstrated by declining function scores, even without any identifiable medical or device complication. This decline may occur due to the effect of aging [24] or the increasing number of patients with a medical infirmity or multiple sites of arthritis [3]. Nevertheless, this potential decline in physical function may not be universal, emphasizing the necessity to maximize the long-term mechanical outcomes of TKA.

We therefore posed the following questions: (1) Does pain relief diminish over 20 years after TKA? (2) Does function decline over 20 years after TKA in terms of Knee Society (KS) function, knee, and walking scores? And (3) what is the patient-reported activity level at the most recent followup?

Patients and Methods

Between January 1975 and December 1989, we performed 2050 cruciate-retaining primary cemented TKAs in 1720 patients. Of these, we excluded 249 patients (14.5%) with 293 TKAs implanted with a metal-backed patella, leaving 1757 TKAs in 1471 patients. We excluded another 108 patients (6.3%) for the following reasons: 14 with deep infections, 44 with implant failures, and 50 patients (56 TKAs) who could not be contacted and were considered lost after 2-year followup. No patient was considered lost to followup before 2 years. Thus, all 50 patients were lost between the 2- and 20-year followup. Eight patients were lost between 2 and 5 years. Another three patients were lost between 5 and 7 years. Another eight patients were lost between 7 and 10 years. One patient was lost between 10 and 12 years. Another 11 patients were lost between 12 and 15 years. The remaining 19 patients were lost after the 15-year followup but before the 20-year followup. This left 1363 patients (79%) with 1643 primary TKAs with a minimum 2-year followup. Four hundred seventy-two Posterior Cruciate Condylar (PCC) TKAs (Howmedica, Rutherford, NJ, USA) were implanted in 402 patients and 1171 Anatomic Graduated Component® (AGC) TKAs (Biomet, Inc, Warsaw, IN, USA) were implanted in 961 patients. One hundred twenty-eight of the 1363 patients (9%) were still living after 20 years of followup; thus, 50 patients known to be living at last followup were lost to followup before the 20-year period yet after the 2-year followup. The data obtained from these patients were included for the period they were followed. The minimum followup in the 128 patients (171 TKAs) was 20 years (mean, 21.1 years; range, 20–27 years). At last followup, 92% (157 TKAs) were considered Charnley Class A, 7% (12 TKAs) Charnley Class B, and 1% (two TKAs) Charnley Class C [13]. There were 39 PCC TKAs and 132 ACG TKAs. Ninety-three (73%) of the patients were women. The diagnosis was osteoarthritis in 82% (140 TKAs). The average age at operation was 63.8 years (range, 18–82 years). The average age at last followup was 82.3 years (range, 45–103 years) (Table 1). Twenty-seven (1.5%) TKAs were revised for aseptic loosening or late instability. These revisions included 13 PCC TKAs (0.7%) and 14 AGC TKAs (0.8%). All revisions occurred before the 20-year followup. There were no implant failures after 20 years. Thus, there were no apparent implant-related problems noted in the cohort of 128 patients (171 TKAs). Sixty-six (73 TKAs) of the 128 patients died after the 20-year followup, leaving 62 patients (98 TKAs) still living at the time of this report. Forty-eight of the 62 living patients were queried via telephone by one of us (LKM) after the most recent clinical followup. The remaining 14 patients were queried by LKM in the office.

Three surgeons (MAR, EMK, PMF) implanted all the TKAs through a medial parapatellar incision. All components were cemented. All patients received the same deep vein thrombosis prophylaxis using 1000 to 1500 U

Table 1. Demographic data

Variable	Value
Number of patients	128
Number of TKAs	171
Posterior Cruciate Condylar	39 (23%)
Anatomic Graduated Component®	132 (77%)
Diagnosis (number of TKAs)	
Osteoarthritis	140 (82%)
Rheumatoid arthritis	24 (14%)
Osteonecrosis	7 (4%)
Sex (number of patients)	
Female	93 (73%)
Male	35 (27%)
Age at operation (years)	
Average	63.8
Range	18–82
SD	8.9
Age at last followup (years)	
Average	82.3
Range	45–103
SD	8.1
Followup (years)	
Average	21.1
Range	20–27
SD	1.6

intravenous heparin sodium intraoperatively and 325 mg aspirin daily for 8 weeks. All patients received either a cephalosporin or vancomycin perioperatively. Full weight-bearing was started on Day 1 postoperatively and ROM was initiated on Day 2. All patients received supervised in-hospital physiotherapy, walking assisted for 4 to 8 weeks. Supervised posthospitalization physiotherapy varied among patients according to need.

The operative surgeon evaluated patients preoperatively and then postoperatively at 8 weeks, 6 months, 1 year, and every 2 to 3 years thereafter. Before 1989 when the KS knee score was published [13], patients were evaluated using the Hospital for Special Surgery (HSS) Rating System [13]. Afterwards, the KS clinical [13] and radiographic [8] scoring system was used. The senior author (MAR) personally, individually, and by hand converted the HSS knee score to the KS knee, pain, function, walking, and stair scores. Thus, these data on all 128 patients were collected prospectively. Furthermore, the 10-point UCLA activity level rating was used to query patients about their participation in certain activities according to this rating system [1, 30]. This evaluation separates activities into 10 different levels ranging from Level 10, regular participation in impact sports such as skiing, jogging, or tennis, to Level 1, being wholly inactive and dependent on others. The UCLA scores, acquired only on the 62 surviving patients, were obtained retrospectively.

ANOVA with least-square means was used to test for differences of scores over time. Statistical analysis was performed using SAS® (SAS Institute Inc, Cary, NC, USA).

Results

Pain scores did not diminish over time (Table 2). At last followup, KS pain scores averaged 48.7 points (range, 20–50 points; SD, 5.4 points). The average KS knee score was 78 points (range, 39–97 points; SD, 14 points). Of the 171 TKAs, 138 TKAs (81%) were rated as pain free (Table 2). KS function, stair, and walking scores diminished over time (Table 3). At last followup, the average KS function score was 70 points (range, 5–100 points; SD, 24 points). The average KS stair score was 35 points (range, 0–50 points; SD, 7.9 points). Furthermore, all but two patients (1.5%, two TKAs) could negotiate stairs up and down (Table 4). The average KS walking score was 37 points (range, 10–50 points; SD, 15 points). Only three patients (2.3%, three TKAs) were considered housebound, and 95 patients (74%, 124 TKAs) could walk at least five blocks. Eighty-two TKAs (48%) were rated

Table 2. Knee Society pain scores

Category	Number of TKAs
None	138 (81%)
Mild or occasional	14 (8%)
Stairs only	5 (3%)
Walking and stairs	5 (3%)
Moderate occasional	9 (5%)
Continuous	0 (0%)
Severe	0 (0%)

Table 3. Clinical Knee Society scores over time for 128 patients (171 TKAs)

Time	Knee score	Function score	Pain score	Stair score	Walking score
Preoperative	54 (11) [14–79]	36 (20) [0–100]	30 (10) [0–50]	30 (11) [0–50]	21 (10) [0–50]
6 months	75 (12) [42–100]	59 (26) [0–100]	47 (4) [20–50]	34 (8) [0–50]	42 (13) [0–50]
1 year	80 (13) [59–100]	69 (24) [20–100]	48 (6) [20–50]	37 (10) [0–50]	47 (9) [10–50]
3 years	87 (13) [55–100]	82 (21) [30–100]	48 (4) [20–50]	41 (10) [0–50]	49 (5) [30–50]
5 years	90 (14) [32–100]	83 (18) [30–100]	49 (4) [10–50]	40 (9) [30–50]	49 (6) [20–50]
7 years	90 (11) [32–100]	81 (18) [30–100]	49 (6) [10–50]	40 (9) [30–50]	48 (7) [10–50]
10 years	88 (9) [54–100]	86 (15) [45–100]	49 (5) [20–50]	41 (9) [30–50]	48 (7) [20–50]
12 years	89 (9) [54–100]	91 (10) [50–100]	49 (2) [30–50]	42 (9) [30–50]	50 (0) [30–50]
15 years	86 (9) [62–98]	83 (18) [45–100]	49 (5) [20–50]	39 (10) [30–50]	45 (11) [20–50]
17 years	84 (9) [52–99]	80 (22) [20–100]	48 (4) [30–50]	39 (10) [15–50]	42 (14) [10–50]
20 years	85 (11) [30–98]	75 (25) [30–100]	49 (6) [10–50]	37 (12) [0–50]	40 (14) [10–50]
p value	0.0075	0.0005	> 0.05	< 0.0001	0.7412

Values are expressed as mean, with SD in parentheses and range in brackets.

Table 4. Knee Society stair scores

Category	Number of TKAs
Normal, up and down	44 (26%)
Normal up, rail down	22 (13%)
Rail up and down	103 (60%)
Rail up, unable down	0 (0%)
Unable	2 (1%)

Table 5. Knee Society walking scores

Category	Number of TKAs
Unlimited	82 (48%)
> 10 blocks	14 (8%)
5–10 blocks	28 (16%)
< 5 blocks	44 (26%)
Housebound	3 (2%)
Unable	0 (0%)

Table 6. UCLA activity scores in 62 patients (98 TKAs)

Level	Number of TKAs
10	15 (15%)
9	20 (21%)
8	32 (33%)
7	15 (15%)
6	11 (11%)
5	5 (5%)
4	0 (0%)
3	0 (0%)
2	0 (0%)
1	0 (0%)

with unlimited walking scores (Table 5). Nevertheless, KS knee, function, pain, stair, and walking scores remained higher than the preoperative values (Table 3).

Of the 62 surviving patients (98 TKAs), the average UCLA activity score was 8.3 points (range, 5–10 points; SD, 1.2 points). Surprisingly, 22 patients (35 TKAs) reported participation in impact activities such as jogging, volleyball, or singles tennis (Table 6). All patients reported active participation in at least some form of moderate activity (ie, Levels 5–10).

Discussion

While TKA provides pain relief and an improved health-related quality of life [7, 8, 12, 20], physical function may decline over time even with what would otherwise be considered a successful long-term outcome of a TKA [24]. The extent of this decline in physical function, independent of prosthetic function, has important implications with respect to ensuring the success of a TKA into the third decade of implantation. This concern is especially important as the average life expectancy in the United States continues to increase to an estimated average of 79.5 years in 2020 [28]. We asked the following questions: (1) Does pain relief diminish over 20 years after TKA? (2) Does function decline over 20 years after TKA in terms of KS function, knee, and walking scores? And (3) what is the patient-reported activity level at the most recent followup?

There are limitations to this study, however. First, as with any long-term study in older patients, we were able to identify only 128 of the original 1471 patients (8.7%) as living. However, we confirmed the other 1341 patients had died. Fifty patients were lost between the 2- and 20-year followup. It is possible some of these 50 patients would still be living and selection bias introduced into the study, thus, skewing the data. With longer periods of followup, patient attrition may tend to occur as patients relocate or prefer to avoid further followup. It is also possible the patients lost to followup may experience prosthetic failure or an inferior clinical result. Interestingly, Joshi et al. [14] in a review of 563 TKAs reported a lower rate of failure for revision surgery and higher satisfactory results in nonattenders compared with patients completing followup. They concluded patients who do not attend followup visits do not necessarily have poor results. Furthermore, these data are similar to those for actuarial data. According to the US National Center for Health Statistics [27], a 65-year-old individual between the years of 1979 and 1991 had a life expectancy of 16.5 to 17.3 years. Furthermore, a life expectancy of 20 years was noted for a 60-year-old individual (living between 1979 and 1991). The average age of those living beyond 20 years in our study was 64 years (± 9 years) at the time of operation. Thus, it appears this followup is at least consistent with the US life tables for the time period under question. Second, although the standard KS clinical and radiographic data were obtained prospectively and available in all 128 patients at the minimum 20-year followup, the UCLA activity scores were obtained retrospectively. As noted above, before 1989, patients were evaluated using the HSS Rating System [13]. This score was then converted to the KS scoring system. Thus, these data on all 128 patients were collected preoperatively, postoperatively, and prospectively. We compared KS knee, function, and activity scores over time, but we were unable to compare the UCLA activity scores over time. Ritter et al. [24] reported, although knee and pain scores do not decline over time after TKA, function scores do decline an average of 0.88 points per year due to decreases in stair and walking scores and the need for support using cane, crutches, or walkers. Similarly, other authors have demonstrated long-term deterioration in joint evaluation scores due to an increasing prevalence of medical comorbid conditions and progression of arthritis at sites other than the joint arthroplasty [3, 15, 17, 29]. Third, only 62 (48%) of the 128 patients still living beyond the 20-year followup were queried for a UCLA activity level. These specific data are not part of our prospective database and, therefore, were unavailable for the 66 deceased patients (73 TKAs from the original cohort). Thus, while we were able to determine the

general functional activity of this patient population over time (KS function, stair, and walking scores), we also wanted to determine a more specific activity level of the patients (UCLA score). Fourth, we recognize activity-rating scales, including the UCLA scale, do not evaluate all aspects of patient activity. While the UCLA score may be sensitive to patient exaggeration, we chose the UCLA because it is a reliable and valid instrument for assessment of activity levels in patients undergoing total joint arthroplasty [18]. This scale correlates closely with pedometer studies [5], investigator VAS [30], and patient's VAS [30]. It has been strongly correlated with the WOMAC (pain, stiffness, function), International Physical Activity Questionnaire, Oxford knee score, KS knee score, KS function score, SF-12 physical component, and SF-12 mental component score [18]. Fifth, our study group may be skewed to a higher activity level because of the relatively low number of patients categorized as Charnley Class C [13]. Indeed, 92% of the study group (157 of the 171 TKAs) was categorized as Charnley Class A (unilateral disease or bilateral disease with the opposite knee successfully replaced) [13]. Benjamin et al. [3] noted a decline in functional knee scores over time related to an increase in percentage of patients in Class C. Schmalzried et al. [26] demonstrated with pedometer testing patients in Charnley Class A were more active than those in Class B or C. We recognize our study group may be skewed to a highly selected group of healthy and active patients who lived 20 years after a successful TKA. Sixth, the functional results and activity scores in this study presume the successful survival of the TKA and the absence of any implant-related problems. While we are reporting 20-year survivorship of the PCC TKA, the ACG TKA reportedly has a 20-year survivorship of 97.8% [22]. Similar survivorship may not necessarily apply to other knee arthroplasty systems unless device complications are minimized or eliminated. Finally, there is no control group of patients without osteoarthritis or prior TKA for comparison. To the author's knowledge, there are no published data on the UCLA activity scores in otherwise healthy octogenarians without osteoarthritis.

Relatively few studies report 20-year followup of TKA [4, 11, 16, 21–23, 25]. Three of these studies include the cemented Total Condylar knee design (Howmedica) [16, 21, 25]. Others report on the LCS® (DePuy Orthopaedics, Inc, Warsaw, IN, USA) [4], cemented AGC [22], uncemented AGC [23], and the Kinematic™ Condylar (Howmedica) [11]. Only two studies report the KS pain scores (Table 7) [22, 23]. The average KS pain score in this review was 49, similar to Ritter [22] and Ritter and Meneghini [23], noting average KS pain scores of 47 and 49, respectively (Table 7).

Five of these studies describe the KS functional score at last followup [4, 11, 22, 23, 25] (Table 7). Only one of these studies specifically divided the function score into its walking and stair components [23].

There is no other long-term study reporting on the UCLA activity score after TKA. However, Dahm et al. [5] reported on 1630 TKAs (1206 patients) followed for an average of 5.7 years and noted an average UCLA activity score of 7.1 at an average age of 70 at final followup. Bauman et al. [2] studied 185 TKA patients with a mean age of 69 years at an average followup of 1 year and noted an average UCLA activity score of 6 points. Fisher et al. [9] noted an average UCLA activity score of 6.5 at an average of 18 months after unicompartmental knee arthroplasty in 71 patients (71 knees). Their average age at operation was 64 years [9].

The limits of the scoring systems used in this study are evident due to several apparent discrepancies between the

Table 7. Published reports including 20-year survivorship of TKA

Study	Number of TKAs	Prosthesis*	Average followup (years)	Average Knee Society function score	Average Knee Society pain score
Callaghan et al. [4]	26	LCS®	21	67	NR
Gill and Joshi [11]	159	Kinematic™ Condylar	10.1	51	NR
Ma et al. [16]	64	Total Condylar	19	NR	NR
Pavone et al. [21]	34	Total Condylar	19	NR	NR
Ritter [22]	6726	AGC	7	76†	47
Ritter and Meneghini [23]	73	AGC (cementless)	20	77	49
Rodriguez et al. [25]	220	Total Condylar	20	58	
Current study	171	AGC/PCC	21	70‡	49

* Prostheses include LCS® (DePuy Orthopaedics, Inc, Warsaw, IN, USA), Kinematic™ Condylar (Howmedica, Rutherford, NJ, USA), Total Condylar (Howmedica), Anatomic Graduated Component® (AGC) (Biomet, Inc, Warsaw, IN, USA), and Posterior Cruciate Condylar (PCC) (Howmedica); †includes average stair score of 37 and average walking score of 41; ‡includes average stair score of 37 and average walking score of 35; NR = not reported.

KS function scores and the UCLA activity scores. Three patients (three TKAs) reported walking was limited to housebound ambulation only. Yet, the UCLA level of activity in these two patients was rated as Level 5 (moderate activity such as shopping). Furthermore, two patients (two TKAs) stated they were unable to negotiate stairs at all. Similarly, UCLA scores were rated as Level 5 in one of these individuals. Not all patients assigned a function score at last followup were alive to have a designated UCLA activity score. Another reason for this apparent discrepancy may be related to the scores being reported not necessarily at the exact same time.

Although aging may cause a gradual decline in physical activity after TKA, improved functional outcomes continue over the long term. Postoperative KS knee, function, pain, stair, and walking scores remained higher than the preoperative values throughout the entire followup. Our observations suggest this group of patients demonstrates remarkable functional capacity over 20 years after the index knee arthroplasty. This long-term functionality demands high implant survivorship and the absence of implant-related complications over time.

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