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Maintenance of Outdoor Walking Ability and Long-Term Outcomes After Primary Total Knee Arthroplasty for Osteoarthritis Versus Rheumatoid Arthritis

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Abstract

Objective: Ambulation is important for maintaining health. We investigated the long-term results and maintenance of outdoor walking ability after total knee arthroplasty (TKA) in patients with osteoarthritis (OA) versus rheumatoid arthritis (RA). **Methods:** We retrospectively reviewed 205 patients with OA (285 knees) and 117 with RA (168 knees) who underwent primary TKA. We investigated the period during which they were able to walk outdoors for more than 10 minutes and the long-term outcomes of TKA. The mean follow-up durations in the OA and RA groups were 13.0 and 12.8 years, respectively. **Results:** The mean ages at surgery in the OA and RA groups were 72.8 and 65 years, respectively. The cumulative frequencies of outdoor walking ability in the OA and RA groups were 39.3% and 44.1%, respectively, at 15 years, and 21.0% and 27.1%, respectively, at 20 years, with no significant intergroup differences (log-rank test, p=0.3017). The main cause of gait dysfunction was medical disease (55.7% and 61.4% in the OA and RA groups, respectively). The cumulative survival rate for TKA was 97% at 20 years in both groups. The preoperative risk factors for inability to walk outdoors were older age at TKA and consistently severe pain in the OA group, and older age at TKA, higher rheumatoid factor concentration, and oral corticosteroid use in the RA group. **Conclusion:** TKA improves long-term knee function and has a similar long-term beneficial effect on outdoor walking ability in patients with OA and RA.

Keywords: Total knee arthroplasty; Osteoarthritis; Rheumatoid arthritis; Outdoor walking; Survival rate

Abbreviations

JOA: Japanese orthopedic association, OA: osteoarthritis, RA: rheumatoid arthritis, ROM: range of motion, TKA: total knee arthroplasty

Introduction

Humans are one of the few animals that can walk on two legs. Walking becomes possible with growth after birth but becomes difficult with aging and can eventually become impossible. Walking becomes difficult when the knee joint is severely damaged by diseases such as osteoarthritis (OA) or rheumatoid arthritis (RA). However, individuals with damaged knee joints can regain walking function through artificial joint intervention. Maintaining the ability to walk outdoors improves quality of life and makes it possible to lead a rich social life. RA severely damages multiple extremity joints through inflammation, while OA often occurs in the knee joint and damages the joint mainly through mechanical factors. Unlike RA, OA rarely has severe effects in multiple joints.

It is very important to understand how the ability to perform various outdoor walking activities is affected by total knee arthroplasty (TKA) for patients with OA and RA with different disease characteristics. There are many reports on the long-term treatment results of TKA [1-4], but few reports have compared the long-term results of TKA for RA *vs.* OA [5-7]. We previously reported the long-term outcomes of TKA and postoperative outdoor walking ability in patients with RA [8]. In the present study, we conducted a longer-term follow-up of patients with RA and compared the outdoor walking ability after TKA for RA versus OA.

Methods and Patients

Patients

In this retrospective study, data from 328 consecutive patients with RA or OA who underwent 460 primary TKAs from 22 August 1997 to 17 December 2007 were reviewed. All surgeries were performed under general anesthesia by a single surgeon at a single institution, and all patients were medically treated by a single physician. Postoperative follow-up and medical treatment for RA were performed by the same

surgeon, as he is also a board-certified rheumatologist approved by the Japanese Rheumatology Association.

The patients were followed up until 18 December 2019 or until death. We evaluated 117 patients (168 joints) with RA and 205 patients (285 joints) with OA. We excluded five patients (6 joints) with OA because these patients changed to another clinic and could not be contacted within 1 year after TKA. All patients with RA fulfilled the 1987 revised American College of Rheumatology criteria for RA [9]. One patient with juvenile idiopathic arthritis was excluded because she was 21 years old at TKA. Patients with OA were assessed as grade 3 or 4 using the Kellgren-Laurence classification of the knee [10].

Implants and Operations

The prosthesis used in all patients was the Genesis 2 (Smith & Nephew, Memphis, TN, USA) [3]. The TKA was the cruciate-retaining type in 83.5% of OA knees and 86.3% of RA knees, while the remainder were the posterior-stabilized type (Table 1). The articular surface of the patella was replaced with an inset convex patella in all but two knees of the RA group.All TKA surgeries were performed via a medial parapatellar approach under general anesthesia by one surgeon at one institution. The details of the surgical procedures and postoperative rehabilitation were described previously [8].

Evaluation Methods

Preoperative conditions such as the age at surgery, height, weight, body mass index, active range of motion (ROM), femorotibial angle on standing radiographs, Japanese Orthopaedic Association (JOA) knee score [11], X-ray findings, and RA activity were evaluated and compared between the RA and OA groups. The cumulative incidence of outdoor walking ability, and cumulative survival rate of the implants were also compared between the RA and OA groups.

The JOA scores rate pain, ROM, manual muscle testing of the quadriceps, ability to ambulate without a cane or brace, and ability to climbs stairs on a cumulative 100-point scale. Pain is assigned 40 points, ROM 12 points, strength of quadriceps muscle 20 points, ability to walk 20 points, and ability to climb stairs 8 point. The JOA knee score, ROM, X-ray findings, and disease activity of RA were evaluated at the final follow-up visit of each patient. The effects of the preoperative serum C-reactive protein concentration, tender joint count, swollen joint count, rheumatoid factor concentration, and use of methotrexate, corticosteroids, and/or biologic agents just before TKA were investigated in the patients with RA.

Forty-two patients with RA and 75 patients with OA were evaluated by direct examination. We also conducted telephone surveys and a postal survey to determine the walking status of 21 patients with RA and 65 patients with OA who had stopped visiting our clinic. Fifty-four patients with RA and 67 patients with OA had died at the end of the study period; for these patients, two medical assistants determined the date of inability to perform outdoor walking and the functional and pain status by discussion with the patients or their families.

The duration of outdoor ambulation was defined as the period between primary TKA and the patient being unable to walk outdoors for over 10 minutes while using a walking aid such as a cane. The duration of outdoor ambulation was also defined as ended when a patient underwent revision TKA.The endpoint of TKA implant survival was the need for revision of any component.

Statistical analysis

The cumulative survival rate of TKA and the cumulative incidence of outdoor walking ability were estimated using the Kaplan-Meier method [12]. Preoperative variables were compared between ambulatory and non-ambulatory patients in the RA and OA groups. As appropriate, statistical analyses were performed using the multivariate regression model, Student's t test, and Fisher's exact test. Risk factors for loss of outdoor walking ability were investigated using the Cox proportional hazard model. For all statistical analyses, $p<0.05$ was considered to indicate significance. All statistical analyses were performed with the Bell curve for Excel (version 4.04) (Social Survey Research Information).

Results

The preoperative patient characteristics are shown in Table 1. For patients who underwent bilateral surgery, the data from the first TKA were used in the analysis. The mean follow-up periods were 13.0 ± 4.1 years in the OA group and 12.8 ± 4.8 years in the RA group.

At surgery, 63 patients with RA were taking oral corticosteroids and 63 were receiving methotrexate. TKA was performed concurrently with biologic treatment using a tumor necrosis factor antagonist in 13 patients.

About 90% of participants in both the OA and RA groups were female. The mean age at TKA was 72.8 years in the OA group and 65 years in the RA group. There was no difference between the OA and RA groups in height, but the weight and body mass index were greater in the OA group. Bilateral knee replacements were performed in 39% of the OA group and 43.6% of the RA group. The mean femorotibial angle was 186.5 ± 6.7° in the OA group and 175.9 ± 7.6° in the RA group (Table 1). The knee ROM improved from 104.5 ± 19.4° preoperatively to 113.8 ± 12.5° at follow-up in the OA group, and from 94.4 ± 26.5° to 110.9 ± 15.3° in the RA group ($p<0.001$). The preoperative ROM and flexion angle were greater in the OA group than the RA group, but there were no significant differences between the two groups in the postoperative extension, flexion angle, and ROM.

The JOA total score improved from 47.3 ± 10.7 preoperatively to 79.1 ± 12.2 at follow-up in the OA group, and from 48.4 ± 12.0 to 81.0 ± 12.8 in the RA group ($p<0.001$). The pain item showed significant improvement from 18.2 ± 7.2 to 38.2 ± 4.4 postoperatively in the OA group, and from 19.7 ± 6.5 to 38.9 ± 3.4 in the RA group ($p<0.001$).

In both the OA and RA groups, the JOA item scores for pain, quadriceps strength, walking unaided, and stair-climbing improved significantly after surgery (p<0.001).

There were no significant differences between the OA and RA groups in the pre- and postoperative JOA scores for all items.

Variable	OA	RA	p-value
Number of patients (joints)	205 (285)	117 (168)	
Female (%)	90.2	89.7	0.8636
Age at TKA (years) [a]	72.8±5.7	65.0±9.5	<0.001
Height (cm) [a]	152.3±7.3	153.5±7.8	0.1829
Body weight (kg) [a]	57.9±9.7	49.8±9.1	<0.001
Bone mass index [a]	24.9±3.4	21.0±3.1	<0.001
Bilateral TKA (patients)	80 (39.0%)	51 (43.6%)	0.1503
CR type of TKA (joints)	238 (83.5%)	145 (86.3%)	0.3473
JOA total score [a]	47.3±10.7	48.4±12.0	0.4129
Range of motion [a]	104.5±19.4	94.4±26.5	<0.001
Femorotibial angle [a]	186.5±6.7	175.9±7.6	<0.001
Follow-up period (years) [a]	13.0±4.1	12.8±4.8	0.7319
MTX use (patients) & dose(mg/week) [a]		63, 5.1±1.2 [a]	
Steroid use (patients) & dose (mg/day) [a]		63, 5.2±3.5 [a]	
Biologic use (patients)		13	

CR: cruciate retention, JOA: Japanese Orthopaedic Association, MTX: methotrexate, OA: osteoarthritis, pts: patients, RA: rheumatoid arthritis, TKA: total knee arthroplasty; [a]Data are expressed as mean ± standard deviation

Table 1: Patients' characteristics at the time of primary total knee arthroplasty.

Revision TKA was performed in seven patients (2.5%) in the OA group and four patients (2.4%) in the RA group. The causes of revision surgery in the OA group were late infection in three cases, knee joint dislocation in two, fracture in one, and patellar pain in one; the reasons for revision surgery in the RA group were mechanical loosening in two cases, fracture in one, and late onset infection in one. There were no cases of early infection within 1 year after TKA. The cumulative TKA survival rate was 97.0% at 20 years in both the OA and RA groups (Figure 1).

The cumulative survival rates of the ability to ambulate outdoors for 10 minutes in the OA and RA groups were 39.3% and 44.1%, respectively, at 15 years, and 21.0% and 27.1%, respectively, at 20 years, with no significant difference between the two groups (log-rank test p=0.3017) (Figure 2).

At final follow-up, there were 115 patients (56.1%) in the OA group and 70 patients (59.8%) in the RA group who were unable to walk outdoors for 10 minutes, and the mean age of these patients at surgery was 74.7 years in the OA group and 68.2 years in the RA group (p<0.008) (Tables 2 and 3). The period until outdoor walking for 10 minutes became impossible was 9.8 ± 4.6 years in the OA group and 9.3 ± 4.9 years in the RA group (p=0.4669).

In the OA group, the ambulatory patients had a greater body weight (p=0.019) and body mass index (p=0.044) than the non-ambulatory patients, and had a greater JOA total score (p<0.001), pain score (p<0.001), walking unaided score (p=0.002), and stair-climbing score (p=0.002). There were no differences between the ambulatory and non-ambulatory patients within the OA group in height, preoperative ROM, or preoperative femorotibial angle (Table 2).

In the RA group, the ambulatory patients were taller (p=0.006) and heavier (p=0.007) than the non-ambulatory patients, but there was no difference between ambulatory and non-ambulatory patients in the body mass index (Table 3). There was also no difference between ambulatory and non-ambulatory patients within the RA group in the ROM, femorotibial angle, or JOA knee score. Compared with ambulatory patients in the RA group, non-ambulatory patients in the RA group had a higher preoperative concentration of rheumatoid factor (p=0.016), but there was no difference between the ambulatory and non-ambulatory patients in the preoperative C-reactive protein concentration, tender joint count, swollen joint count, methotrexate use, corticosteroid use, and biologic agent use.

In both the OA and RA groups, the most common causes of inability to walk outdoors for 10 minutes were cerebrovascular disorders, dementia, heart disease, malignant tumors, and other medical diseases (OA group: 64 cases, 55.7%; RA group: 43 cases, 61.4%).

The cause of inability to walk outdoors was thought to be senility without other causative complications in 35 (30.4%) patients in the OA group and eight (11.4%) in the RA group (p=0.0037, Fisher's exact test). Gait dysfunction due to spinal disease was found in seven patients in the RA group and five in the OA group (p=0.2163). Periprosthetic joint fractures occurred in 5 patients with OA and 6 with RA. Of the eleven patients, one patient with OA and one patient with

RA who requested long-term conservative treatment developed an inability to walk outdoors.

The Cox proportional hazards regression analysis revealed that older age and a worse preoperative JOA pain score were risk factors for the inability to walk outdoors in the OA group (Table 2); height, weight, bilateral knee replacement, femorotibial angle, and JOA items other than pain were not risk factors. In the RA group, the risk factors for gait dysfunction were older age at TKA, higher rheumatoid factor concentration, and corticosteroid use (Table 3).

Pre-operative variable	Walk	Not walk	Coefficient	Hazard ratio	95% CI	p value
Age at TKA	70.5±5.8	74.7±5.1	0.0556	1.0571	1.01 - 1.10	0.0082
Height (cm)	153.2±6.9	151.6±7.5	-0.0156	0.9845	0.95 - 1.02	0.4075
Weight (kg)	59.7±8.8	56.5±10.2	-0.0026	0.9974	0.97 - 1.02	0.8468
TKA (unilateral:1, bilteral:2)	1.3±0.5	1.4±0.5	-0.2431	0.7842	0.52 - 1.19	0.2489
ROM (degree)	106.9±16.9	102.9±20.6	-0.0093	0.9907	0.97 - 1.01	0.2710
Femorotibial angle (degree)	186.8±4.9	186.1±8.1	-0.0079	0.9922	0.96 - 1.02	0.5981
JOA score (100 point)	50.8±9.4	44.5±10.9	-0.0169	0.9832	0.96 - 1.00	0.0891
Pain (40 point)	20.4±7.2	16.4±6.8	-0.0395	0.9612	0.93 - 0.99	0.0091
ROM (12 point)	8.7±1.2	8.4±1.6	0.0030	1.0030	0.81 - 1.24	0.9780
Quadriceps (20 point)	10.3±2.8	10.3±2.5	0.0760	1.0790	0.99 - 1.18	0.0946
Walking (20 point)	9.4±2.3	8.0±4.0	0.0189	1.0191	0.96 - 1.08	0.5388
Stairs (8 point)	1.9±0.9	1.4±1.1	-0.0748	0.9279	0.75 - 1.15	0.4980

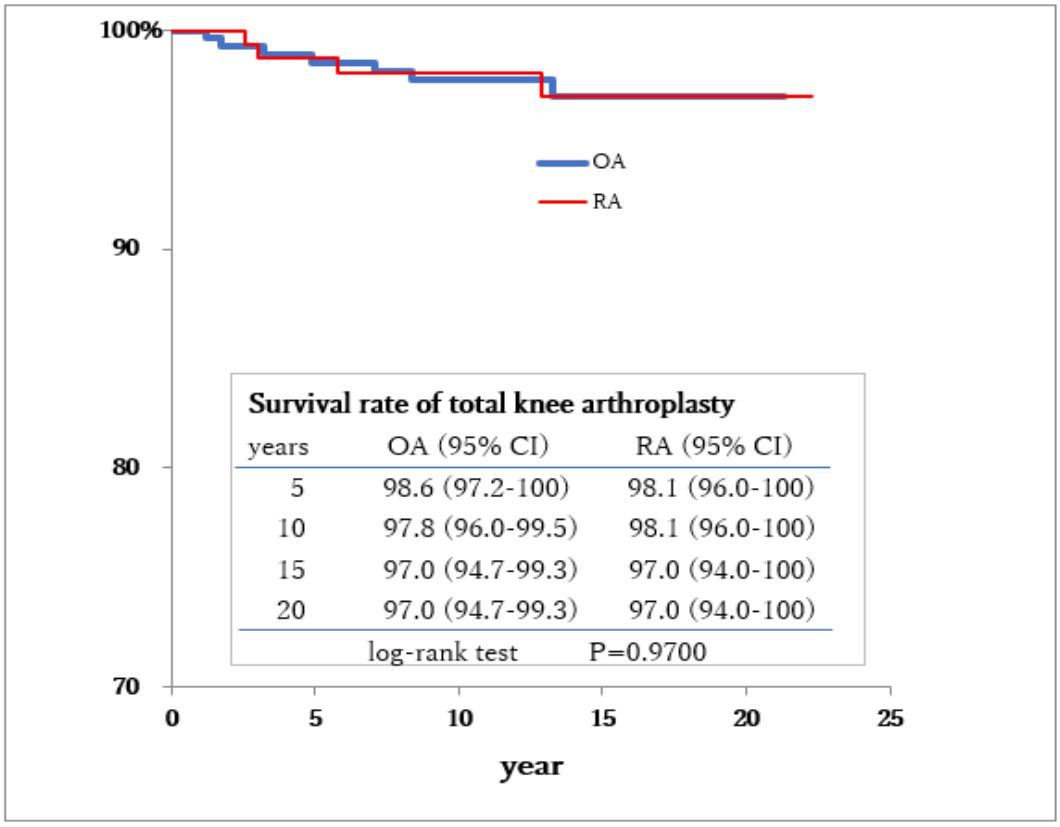
JOA: Japanese Orthopaedic Association, ROM: range of motion, TKA: total knee arthroplasty

Table 2: Cox proportional hazard regression analysis of preoperative variables to identify risk factors for inability to walk outdoors after TKA in patients with osteoarthritis.

Pre-operative valuable	Walk	Not walk	coefficient	Hazard ratio	95% CI	p value
Age at TKA (year)	60.2±9.6	68.2±8.1	0.1275	1.1360	1.08-1.19	< 0.001
Height (cm)	155.9±7.3	151.9±7.7	0.0033	1.0033	0.95-1.05	0.8870
Weight (kg)	52.5±8.4	47.9±9.1	-0.0127	0.9874	0.94-1.03	0.5726
TKA (unilateral:1, bilteral:2)	1.4±0.5	1.4±0.5	-0.0957	0.9088	0.52-1.58	0.7359
Femorotibial angle	176.0±7.1	176.8±8.1	0.0027	1.0027	0.96-1.05	0.8976
ROM (degree)	89.1±30.0	97.9±23.5	0.0150	1.0151	1.00-1.03	0.0852
JOA score (100 point)	47.2±14.7	49.1±9.9	-0.0460	0.9549	0.79-1.16	0.6358
Pain (40 point)	19.1±7.5	20.1±5.8	-0.0222	0.9780	0.93-1.03	0.3740
ROM (12 point)	7.9±2.0	8.1±1.7	-0.1323	0.8761	0.68-1.14	0.3344
Quadriceps (20 point)	10.0±5.1	10.6±3.4	0.0077	1.0077	0.94-1.09	0.8377
Walking (20 point)	8.5±4.7	8.6±3.9	-0.0005	0.9995	0.92-1.09	0.9904
Stairs (8 point)	1.7±1.6	1.7±1.8	-0.0465	0.9545	0.79-1.16	0.6364
Rheumatoid factor (IU/ml)	117.6±119.2	202.6±216.3	0.0030	1.0030	1.00-1.00	< 0.001
C-reactive protein (mg/dl)	3.6±3.6	4.1±3.4	0.0501	1.0513	0.97-1.14	0.2413
Tender joint count	6.0±7.5	6.0±6.1	0.0088	1.0089	0.95-1.08	0.7759
Swelling joint count	10.9±8.8	9.8±7.2	-0.0380	0.9627	0.91-1.02	0.2074
MTX-use 0: no, 1: use	0.6±0.5	0.5±0.5	0.1079	1.1139	0.63-1.97	0.7118
Steroid-use 0: no, 1: use	0.5±0.5	0.6±0.5	1.1400	3.1267	1.64-5.95	< 0.001
Biologics use 0: no, 1: use	0.2±0.4	0.1±0.3	-0.2860	0.7512	0.28-2.04	0.5747

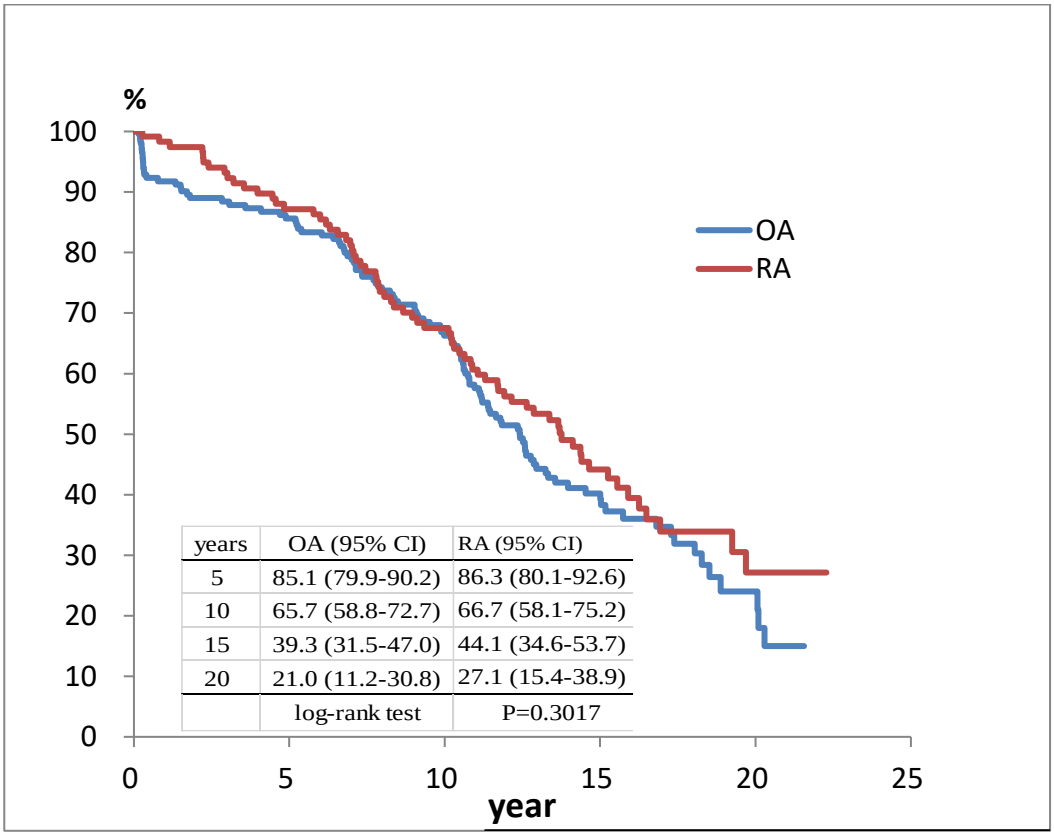
JOA: Japanese Orthopaedic Association, ROM: range of motion, MTX: methotrexate, TKA: total knee arthroplasty

Table 3: Cox proportional hazard regression analysis of preoperative variables to identify risk factors for inability to walk outdoors after TKA in patients with rheumatoid arthritis.



CI: confidence interval; OA: osteoarthritis; RA: rheumatoid arthritis

Figure 1: Cumulative survival rate of total knee arthroplasty in the OA and RA groups.



CI: confidence interval; OA: osteoarthritis; RA: rheumatoid arthritis

Figure 2: Cumulative incidence of outdoor walking ability after total knee arthroplasty in the OA and RA groups.

Discussion

Few studies have compared the treatment outcomes after TKA in patients with OA versus RA [5-7, 13-16]. Furthermore, no studies have compared the long-term treatment results and duration of outdoor walking ability after TKA in patients with OA versus RA. In 2021, we reported that the cumulative survival rate for outdoor walking ability after TKA in patients with RA was about 48% at 15 years [8].

In the present study, we further investigated the long-term results of TKA for patients with RA, and compared these findings with the duration of outdoor walking ability and long-term results of patients with OA who underwent TKA during the same period. The cumulative rates for the maintenance of outdoor walking ability after TKA in the OA and RA groups were 39% and 44%, respectively, at 15 years, and 21% and 27%, respectively, at 20 years, with no differences between the OA and RA groups (p=0.3017). The frequency of revision TKA was seven of 285 joints (2.5%) in the OA group, and four of 168 joints (2.4%) in the RA group. The cumulative survival rate of TKA was 97.0% at 20 years after surgery in both the OA and RA groups (Fig. 1).

Regarding the preoperative condition, the mean age at surgery was older in the OA group (72.8 years) than the RA group (65 years). There were no differences between the OA and RA groups in height, but the mean preoperative weight and body mass index were greater in the OA group. There was no difference between the OA and RA groups in the preoperative JOA total score. However, the mean preoperative ROM was greater in the OA group than the RA group (Table 1).

The JOA score showed marked improvement postoperatively in both groups. In particular, the pain item showed a marked improvement but did not differ between the OA and RA groups. The postoperative ROM also did not differ between the OA and RA groups. Previous comparisons of short-term postoperative outcomes at 2–5 years between the OA and RA groups have reported no differences in knee ROM, knee function, or patient-rated assessment [5-7,13,15,16]. The present study found no significant difference between the OA and RA groups in the long-term knee joint function after TKA.

Previous studies comparing the results of TKA for OA versus RA have reported that the RA group has a high frequency of revision and infection [5,14,17,18], and a low cumulative survival rate of TKA [5,18]. In the present study, the frequency of infection in the RA group was lower than that reported in previous studies [5, 14, 17, 18], which is probably the reason why there was no difference in the cumulative survival rate of TKA between the OA and RA groups.

Aging-related medical diseases, namely cerebrovascular disease, pulmonary disease, heart disease, malignant tumors, and dementia, were the cause of gait dysfunction in 64 (55.7%) patients in the OA group and 43 (61.4%) patients in the RA group. Thirty-five (30.4%) patients with OA and eight (11.4%) with RA without apparent comorbidities were unable to walk outdoors (p=0.0037). These patients were diagnosed with senility, but it is possible that they may also have had sarcopenia as age-related muscle weakness [19].

Of the 11 periprosthetic fractures, 2 patients became unable to walk outdoors. It has previously been reported that additional lower extremity surgery after primary TKA is not a risk factor for cumulative outdoor walking duration in the RA group [8]. The main cause of inability to walk outdoors was various medical complications associated with aging, rather than the function of the knee joint.

Cox proportional hazard regression analysis showed that the risk factors for inability to walk outdoors in the OA group were older age at TKA and consistently severe knee pain. It is unclear why patients with severe pain were at increased risk of inability to walk outdoors. The risk factors for inability to walk outdoors in the RA group were older age, higher rheumatoid factor concentration, and use of corticosteroids (Tables 4 and 5). A previous study reported that the risk factors for inability to walk outdoors after TKA were older age, lower body weight, corticosteroid use, higher rheumatoid factor concentration, and no-use of biologic agents (8); however, low body weight and no-use of biologic agents were not risk factors in the present study. The reason for this may be that the present survey included a greater number of non-ambulatory patients and a smaller number of patients using biologic agents.

The present study has some limitations. First, the number of patients analyzed might be considered relatively low, especially with regard to the number of male patients. Second, we did not acquire data on patient satisfaction after TKA [20,21]. Third, as we were unable to directly examine patients who changed physicians or died, we could not determine the detailed causes of these patients' inability to continue outdoor ambulation.

Despite these limitations, the present study has several advantages. All patients with OA and RA were operated on by a single doctor and underwent the same postoperative rehabilitation protocol and received the same basic medications. The data were not influenced by surgeons' and rheumatologists' differences in treatment, which suggests that the outcomes were less vulnerable to potential confounding issues.

Conclusion

We investigated the period during which patients who had undergone primary TKA for OA and RA were able to walk outdoors for more than 10 minutes and the long-term treatment results of TKA. There was no significant difference between the OA and RA groups in knee joint function after TKA, even in the long-term. The cumulative survival rate for TKA was 97% at 20 years in both the OA and RA groups. At 20 years after surgery, 21% of the OA group and 27% of the RA group maintained their outdoor walking ability. Although there was a difference between the OA and RA groups in the age at surgery, there was no difference in the cumulative survival rate of the ability to ambulate outdoors. The main cause of inability to walk outdoors was various medical complications associated with aging, rather than the function

of the knee joint. The risk factors for inability to walk outdoors were older age at surgery and severe pain in the OA group, and older age, higher rheumatoid factor concentration, and oral corticosteroid use in the RA group.

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Conflict of interest

No.

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