Table 1 Baseline characteristics of the rheumatoid arthritis patients treated with tocilizumab (TCZ) who were enrolled in the present study

	All cases (n = 122)						Prior use of anti-TNF agent		No prior use of anti-TNF agent (TCZ as 1st-line biologic)	
							With anti-TNF agent (n = 72)	Without anti-TNF agent (n = 50)	Baseline disease duration ≤12 months (n = 10)	Baseline disease duration >12 months (n = 40)
	Mean ± SD	Median	25th percentile	75th percentile	Min	Max	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Gender, female (%)	77.1						75.0	80.0	70.0	82.5
Age (years)	55.8 ± 13.5	59.0	46.0	66.0	24.0	82.0	55.0 ± 13.9	57.0 ± 13.0	56.8 ± 14.2	57.1 ± 12.9
RA duration (months)	124.1 ± 112.8	96.5	39.5	170.3	0	607.0	126.4 ± 117.0	120.9 ± 107.5	6.4 ± 4.5	149.6 ± 101.5
Steinbrocker stage scores (I/II/III/IV)	19/29/24/50						9/14/19/30	10/15/5/20	4/5/0/1	6/10/5/19
Steinbrocker class scores (1/2/3/4)	17/60/45/0						6/36/30/0	11/24/15/0	4/5/1/0	7/19/14/0
Previous anti-TNF agent use (%)	59.0						100.0	0.0	–	–
MTX use (%)	38.5						44.4	30.0	0.0	37.5
Baseline MTX dose (mg/week)	7.5 ± 2.0	8.0	6.0	8.0	2.0	12.0	7.6 ± 2.1	7.3 ± 2.0	–	7.3 ± 2.0
Corticosteroid use (%)	69.7						80.6	54.0	60.0	52.5
Prednisolone dose (mg/day)	4.7 ± 2.0	5.0	3.0	5.0	1.0	10.0	4.9 ± 2.0	4.3 ± 1.9	5.4 ± 2.5	3.9 ± 1.6
TJC (/28)	8.9 ± 7.4	6.5	4.0	12.0	0	28.0	9.6 ± 8.0	7.8 ± 6.3	8.4 ± 5.3	7.6 ± 6.6
SJC (/28)	7.1 ± 5.8	5.5	3.0	10.0	0	26.0	7.8 ± 6.6	6.1 ± 4.4	6.6 ± 3.7	5.9 ± 4.6
PtGA (mm)	55.6 ± 25.7	50.5	33.0	75.8	9.0	100.0	58.2 ± 26.7	51.9 ± 23.8	51.7 ± 27.8	52.0 ± 23.1
ESR (mm/h)	67.0 ± 34.3	65.5	40.0	94.3	2.0	100.0	70.6 ± 35.1	61.8 ± 32.7	71.4 ± 37.0	59.4 ± 31.7
CRP (mg/dL)	3.5 ± 2.9	3.1	1.2	5.1	0.1	17.7	4.2 ± 3.1	2.6 ± 2.2	2.6 ± 3.0	2.6 ± 2.0
DAS28-ESR	5.8 ± 1.3	5.7	4.9	6.6	2.1	9.2	6.0 ± 1.4	5.6 ± 1.1	5.8 ± 1.3	5.5 ± 1.0

SD standard deviation, *RA* rheumatoid arthritis, *TNF* tumor necrosis factor, *MTX* methotrexate, *TJC* tender joint count (28-joint count), *SJC* swollen joint count (28-joint count), *PtGA* patient global assessment, *ESR* erythrocyte sedimentation rate, *CRP* C-reactive protein, *DAS28* 28-joint count disease activity score

(16.0 % at 6 months and 20.0 % at 12 months) than in those who had (6.9 % at 6 months and 12.5 % at 12 months), as was observed under the conventional criterion, but again this was not significant (Fig. 2d).

Then, presuming the application of the most recent EULAR recommendations and T2T, we divided the 50 patients who had received TCZ as a first-line biological drug into two groups [those with a disease duration at baseline of 12 months or less (≤12 M) and those with a disease duration at baseline of longer than 12 months (>12 M)]. In this situation, the DAS28-ESR scores were improved in both groups, changing from 5.8 ± 1.3 at baseline to 2.8 ± 1.6 at 6 months and 2.6 ± 1.4 at 12 months in the ≤12 M group, and from 5.5 ± 1.0 at baseline to 2.9 ± 1.4 at 6 months and 2.8 ± 1.6 at 12 months in the >12 M group. Thus, there was no significant difference between the changes seen in the two groups (Fig. 2e). Under the conventional criterion, the remission rates were comparable between the two groups: 50.0 % at 6 months and 50.0 % at 12 months in the ≤12 M group, and 47.5 % at 6 months and 50.0 % at 12 months in the >12 M group. Upon applying the new criterion, however, a difference appeared at 6 months, with remission rates of 40.0 % in the ≤12 M group against 10.0 % in the >12 M group (p = 0.0407). This disparity was maintained at the 12-month point as well, with remission rates of 50.0 % in the ≤12 M group against 12.5 % at 12 months in the >12 M group (p = 0.0181) (Fig. 2f).

Among the individual components of the new criterion (TJC ≤1, SJC ≤1, PtGA ≤1 cm, and CRP ≤1 mg/dL), the rate of achievement of PtGA ≤1 cm was significantly higher after 6 months in patients with a disease duration at baseline of 12 months or less (p = 0.0181) (Fig. 3).

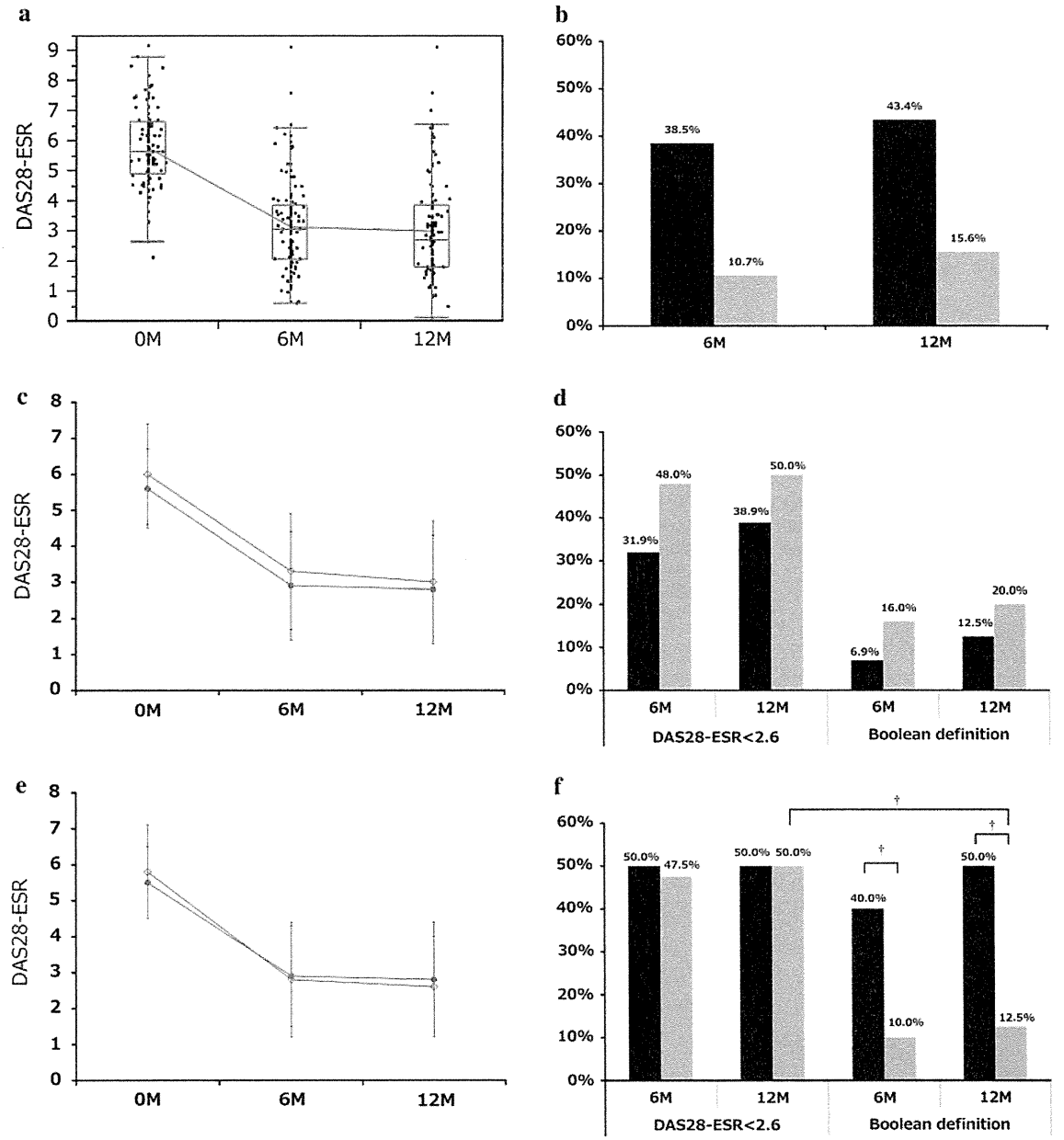

Fig. 2 Changes over time in DAS28-ESR, remission rates under the conventional criterion (DAS28-ESR <2.6), and remission rates under the new criterion (Boolean definition: all ≤1) in all patients ($n = 122$), in patients who had previously used anti-TNF agents, and by duration of disease at baseline (>12 vs. ≤12 months) for patients using TCZ as a first-line biologic. *DAS28* 28-joint count disease activity score, *ESR* erythrocyte sedimentation rate, *TNF* tumor necrosis factor, *6 M* 6 months, *12 M* 12 months. **a** Changes over time in DAS28-ESR in all patients ($n = 122$). The DAS28-ESR scores for the 122 patients were improved at 6 months ($p < 0.0001$). **b** Remission rates under conventional remission criteria (*black bars*) and new criteria (*gray bars*) in all patients ($n = 122$). **c** Changes over time in DAS28-ESR in patients who had previously used an anti-TNF agent (*empty squares*, $n = 72$) versus patients who had not previously used an anti-TNF agent (*filled circles*, $n = 50$). **d** Remission rates under the conventional and new criteria in patients who had (*black bars*) and had not (*gray bars*) previously used an anti-TNF agent. **e** Changes over time in DAS28-ESR by duration of disease at baseline in patients who used TCZ as a first-line biologic: disease duration ≤12 months (*empty squares*, $n = 10$) versus >12 months (*filled circles*, $n = 40$). **f** Remission rates under the conventional and new criteria by duration of disease at baseline in patients who used TCZ as a first-line biologic: disease duration ≤12 months (*black bars*) versus >12 months (*gray bars*). †Fisher's exact test, remission rate under the new criterion, >12 versus ≤12 months; 6 M ($p = 0.0407$), 12 M ($p = 0.0181$). Conventional criterion versus new criterion 12 M ($p < 0.0001$)

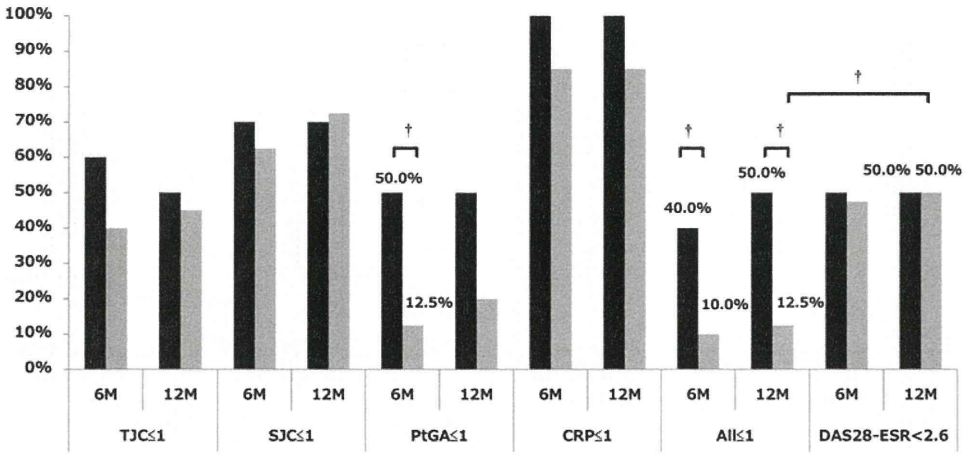

Fig. 3 Rates of achievement of TJC ≤1, SJC ≤1, PtGA ≤1 (cm), and CRP ≤1 (mg/dL) under the new remission criterion by duration of disease at baseline (>12 vs. ≤12 months) in patients using TCZ as a first-line biologic: *black bars* ≤12 months; *gray bars* >12 months. *TJC* tender joint count (28-joint count), *SJC* swollen joint count (28-joint count), *PtGA* patient global assessment, *CRP* C-reactive protein, *DAS28* 28-joint count disease activity score, *6 M* 6 months, *12 M* 12 months. †Fisher's exact test, >12 versus ≤12 months. PtGA ≤1: 6 M ($p = 0.0181$). All ≤1: 6 M ($p = 0.0407$), 12 M ($p = 0.0181$)

Table 2 Patient baseline factors for achieving remission at 12 months after the initiation of TCZ treatment under the conventional criterion and under the new criterion, and patient baseline factors in group A (those who did not meet the new criterion but met the conventional criterion) and group B (those who met both the new and conventional criteria), as determined by univariate logistic analysis

Baseline clinical parameters	Conventional remission		New remission		Group A/group B	
	Chi-square	*p* value	Chi-square	*p* value	Chi-square	*p* value
Gender	4.27	0.0387	0.05	0.8305	1.61	0.2048
Age	0.19	0.6619	3.32	0.0686	4.59	0.0321
RA duration	1.62	0.2038	9.65	0.0019	6.56	0.0105
Steinbrocker stage scores	3.54	0.0601	11.33	0.0008	8.38	0.0038
Steinbrocker class scores	4.73	0.0296	6.84	0.0089	3.40	0.0652
Previous anti-TNF agent use	1.48	0.2245	1.24	0.2649	0.35	0.5522
MTX use	1.80	0.1802	0.12	0.7273	0.12	0.7284
Corticosteroid use	7.30	0.0069	7.37	0.0066	2.48	0.1153
TJC	11.10	0.0009	2.15	0.1429	0.26	0.6131
SJC	6.89	0.0087	3.16	0.0753	0.56	0.4555
PtGA	11.14	0.0008	3.12	0.0773	0.02	0.9004
ESR	4.64	0.0312	2.68	0.1018	0.54	0.4633
CRP	0.30	0.5846	0.36	0.5500	0.77	0.3812
DAS28-ESR	14.59	0.0001	3.90	0.0482	0.00	0.9979

RA rheumatoid arthritis, *TNF* tumor necrosis factor, *MTX* methotrexate, *TJC* tender joint count (28-joint count), *SJC* swollen joint count (28-joint count), *PtGA* patient global assessment, *ESR* erythrocyte sedimentation rate, *CRP* C-reactive protein, *DAS28* 28-joint count disease activity score, *Group A/group B* the patients were divided into group A, who met the conventional but not the new criterion (34 patients), and group B, who met both the conventional and new criteria (19 patients)

Identification of the factors that contribute to remission under the conventional and new criteria

Baseline data on gender, age, RA duration, stage, class, previous use of an anti-TNF agent, MTX use, corticosteroid use, TJC, SJC, PtGA, ESR, CRP, and DAS28-ESR for the patients treated with TCZ were used in a univariate logistic analysis (Table 2). The factors that multivariate logistic analysis identified as contributing to the achievement of remission at 12 months after the initiation of TCZ treatment under the conventional criterion were RA duration [odds ratio (OR) 0.9956, 95 % confidence interval (CI)

0.9910–0.9997], corticosteroid use (OR 0.2536, CI 0.0863–0.6876), TJC (OR 0.8698, CI 0.7866–0.9457), ESR (OR 0.9577, CI 0.9356–0.9772), and CRP (OR 1.7700, CI 1.3530–2.4636). The contributory factors under the new remission criterion were RA duration (OR 0.9787, CI 0.9644–0.9899), corticosteroid use (OR 0.2422, CI 0.0661–0.8210), SJC (OR 0.8109, CI 0.6723–0.9488), ESR (OR 0.9749, CI 0.9483–0.9989), and CRP (OR 1.4336, CI 1.0608–1.9684). The baseline items that contributed to remission according to both the conventional and new criteria were thus RA duration, corticosteroid use, and CRP. After assigning patients who had achieved remission under the conventional criterion but failed to do so under the new criterion to group A ($n = 34$), and those who had achieved remission under both the conventional and new criteria to group B ($n = 19$), we carried out multivariate analysis (note that no patient failed under the conventional criterion and succeeded under the new criterion only, and 69 patients failed to achieve remission under either the new or conventional criterion).

The analysis identified RA duration only (OR 1.0190, CI 1.0077–1.0343) (Table 3).

Discussion

In evaluations of the clinical response to TCZ using the conventional remission criterion of DAS28-ESR <2.6, the weights of CRP and ESR are higher than those of the TJC and SJC data [12, 13], which has been reported to give rise to disparately higher remission rates [15–18] than those indicated by the SDAI with the new remission criteria [4, 19], the CDAI [4, 20], or the Boolean definition [4].

However, those papers review the results for TCZ used in patients with a disease duration of about 10 years, and are not related to findings from investigations based on treatment guidelines or goals and remission criteria that seek to improve patient outcomes, such as those that have been proposed internationally in recent years.

In this study, we reviewed the progress of patients in the TBC registry who were started on TCZ treatment in the "early phase" of the disease; that is, those with an RA duration of 12 months or less at the initiation of TCZ treatment. Co-author Dr. Kojima previously reported that RA patients with a disease duration of <4.8 years that were treated with TCZ for 52 weeks showed a significantly higher remission rate than patients with a longer disease duration, based on DATA from TBCR [10]. However, in that work, we did not analyze early-phase RA patients who were treated with TCZ based on the recommendations of EULRA. In the present work, we found that if TCZ was given early and, moreover, as the first-line biological drug (in accordance with the EULAR recommendations), remission rates as high as 50.0 % at 12 months could be achieved using the new stricter remission criteria of the Boolean definition. We were also able to confirm that these findings were comparable with remission rates obtained based on the conventional criterion DAS28-ESR <2.6.

On the other hand, in patients with an RA duration exceeding 12 months, there was considerable disparity between the remission rates of 50 % obtained under the conventional criterion and 12.5 % under the new criterion

Table 3 Multivariate logistic analysis-based extraction of patient baseline factors for achieving remission under the conventional and new criteria, and extraction of patient baseline factors in group A (those who did not meet the new criterion but did meet the conventional criterion) and group B (those who met both the new and conventional criteria)

Baseline clinical parameters	Conventional remission		New remission		Group A/group B	
	Odds ratio (95 % confidence interval)	*p* value	Odds ratio (95 % confidence interval)	*p* value	Odds ratio (95 % confidence interval)	*p* value
Gender	–	–	4.4029 (0.9264–27.9475)	0.0836	0.2680 (0.0462–1.2500)	0.1113
Age	1.0348 (0.9963–1.0772)	0.0828	–	–	–	–
RA duration	0.9956 (0.9910–0.9997)	0.0413	0.9787 (0.9644–0.9899)	0.0012	1.0190 (1.0077–1.0343)	0.0040
Corticosteroid use	0.2536 (0.0863–0.6876)	0.0089	0.2422 (0.0661–0.8210)	0.0252	–	–
TJC	0.8698 (0.7866–0.9457)	0.0026	–	–	–	–
SJC	–	–	0.8109 (0.6723–0.9488)	0.0159	1.1935 (0.9316–1.6209)	0.1959
PtGA	0.9804 (0.9598–1.0001)	0.0567	–	–	–	–
ESR	0.9577 (0.9356–0.9772)	<0.0001	0.9749 (0.9483–0.9989)	0.0510	1.0249 (0.9945–1.0609)	0.1249
CRP	1.7700 (1.3530–2.4636)	0.0002	1.4336 (1.0608–1.9684)	0.0191	0.4951 (0.1380–1.4795)	0.2348

Multivariate logistic regression models (stepwise selection)

RA rheumatoid arthritis, *TNF* tumor necrosis factor, *MTX* methotrexate, *TJC* tender joint count (28-joint count), *SJC* swollen joint count (28-joint count), *PtGA* patient global assessment, *ESR* erythrocyte sedimentation rate, *CRP* C-reactive protein, *DAS28* 28-joint count disease activity score, *Group A/group B* the patients were divided into group A, who met the conventional but not the new criterion (34 patients), and group B, who met both the conventional and new criteria (19 patients)

(Fig. 2f). If we consider the baseline characteristics (Table 1), this disparity appears to have been caused by differences in disease stage, which indicates the degree of disease progression.

The Health Assessment Questionnaire (HAQ) devised by Smolen and colleagues is constructed from an activity-related HAQ (ACT-HAQ) component and a damage-related HAQ (DAM-HAQ) component. It has been pointed out that the DAM-HAQ is correlated with the total Sharp score (TSS), and that if DAM-HAQ continues to worsen, no improvement in HAQ score can occur [21]. The salient points here are the effects arising from the irreversible progression of the disease and the poor correlation between clinical remission, such as that indicated by DAS representing inflammatory symptoms, and structural or functional remission.

Our study likewise indicated that, although an improved TJC or SJC (reflecting an improvement in inflammatory symptoms) may be seen, regardless of the disease duration (Fig. 3), only a small proportion of those with an RA duration exceeding 12 months at the initiation of TCZ treatment achieved PtGA $\leq$1 cm, and this had a major impact on the remission rate. Moreover, disease duration up to the initiation of TCZ treatment was also demonstrated to be a significant factor in achieving remission, not only under the conventional criterion but also under the new criterion (Table 3). In short, it appeared that patients with longer RA durations suffered irreversible progression of the disease, and that the PtGA could not be improved.

In summary, tocilizumab used as a first-line biological drug in patients with early-stage rheumatoid arthritis in accordance with the EULAR recommendations appears to provide high rates of remission, even under the new stricter criterion, and it can help to achieve the current goals of treatment.

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Conflict of interest N. Ishiguro received lecture fees (less than $10,000) from Mitsubishi Tanabe Pharma Corporation, Takeda Pharma Corporation, Eisai Pharma Corporation, Chugai Pharma Corporation, Bristol-Myers Squibb, and Abbott Laboratories. T. Kojima and A. Kaneko also received lecture fees (less than $5,000) from these companies. The other authors declare no conflict of interest.

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Patellar Fracture After Total Knee Arthroplasty for Rheumatoid Arthritis

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Abstract: Patellar fracture is one of the most challenging complications of total knee arthroplasty, but relatively, little is known about it in patients with rheumatoid arthritis. We retrospectively analyzed 329 total knee arthroplasties performed in 230 female patients with rheumatoid arthritis to identify the incidence and risk factors for postoperative patellar fractures. The mean age was 61.8 years, and the mean follow-up period was 6.2 years. Patellar resurfacing was performed in all cases. Five postoperative patellar fractures (1.51%) were identified, and a thin residual patellar thickness and the use of posterior-stabilizing components were identified as significant risk factors, although the number of fractures was small in both groups. There was also tendency of higher age and greater joint line change observed in patients with fracture compared with those without fracture. **Keywords:** patellar fracture, total knee arthroplasty, rheumatoid arthritis, postoperative complication, risk factor.

Total knee arthroplasty (TKA) is an effective treatment option relieving arthritic pain and restoring the function and activity of daily living in patients with osteoarthritis (OA) and rheumatoid arthritis (RA). Although patellar resurfacing is a common surgical procedure in TKA, it is sometimes associated with complications such as fracture, subluxation, component loosening, and patellar clunk syndrome. Patellar fractures are rare but also comprise one of the most challenging complications of TKA. Previous reports have provided valuable information concerning the prevalence and risk factors for postoperative patellar fractures. However, most of the studies have focused on patients with OA, and only a few studies analyzed patients with RA [1-3]. In the present study, we examined the incidence of patellar fractures in female patients with RA after TKA with patellar resurfacing, and analyzed the risk factors. We also discuss the treatment strategy and the outcome in these fracture cases.

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Materials and Methods

This is a retrospective study and was approved by the research ethics committee of our hospital. Three hundred twenty-nine TKAs, which had been performed in 230 female patients with RA between 1992 and 2009 at one hospital, were retrospectively analyzed. Patients with less than 1 year of follow-up or with infection were excluded. Surgeries were performed by 4 orthopedic surgeons. The mean age at the time of surgery was 61.8 years (range, 30-85 years), and the mean follow-up period after TKA was 6.2 years. One hundred twenty of the implants were NexGen (Zimmer, Warsaw, IN), 105 were Scorpio (Stryker), 61 were AGC (Biomet, Warsaw, IN), 42 were Maxim (Biomet), and 1 was Miller-Galante (Zimmer). Three hundred six cruciate-retaining (CR) prostheses and 23 posterior-stabilizing (PS) prostheses were used. Patellar resurfacing was performed in all cases, and all of the components were cemented.

The Insall-Salvati ratio was calculated by dividing the patellar length by the patellar tendon length, as seen in the postoperative lateral radiographs taken with a measure. The change in the vertical level of the femorotibial joint line (joint line change) was measured by comparing the preoperative and postoperative lateral radiographs as previously reported [4]. In brief, preoperative joint line represents the distance from the tibia tubercle to the tibia plateau, and postoperative joint line is measured from the tibia tubercle to the weight-bearing surface of the tibial prosthesis. Residual bone thickness of the patella (patellar thickness) was measured from outer surface to the bone-cut line in the

Table 1. Patients with Patellar Fracture After TKA

Case	Age (y)	Time to Fracture (mo)	Trauma	Fracture Type	Implant
1	67	26	Yes	II	NexGen CR
2	64	1	No	II	NexGen CR
3	69	8	No	II	Scorpio PS
4	77	2	No	II	Scorpio PS
5	68	60	No	III	Miller-Galante PS

postoperative radiographs. The data on the lateral retinacular release (ie, performed or not) were collected from the surgical records.

For the assessment of risk factors associated with patellar fractures, the baseline characteristics, intraoperative factors, and radiographic parameters were compared between patients with and without patellar fracture, using the χ^2 test for the categorical variables and nonpaired *t* tests for numerical variables. Univariate logistic regression models were used to test the association between patellar fracture and risk factors. Then, the receiver operating characteristic curves were used to determine the optimal cutoff values.

Multivariable models were used to adjust for age and confounding factors. All analyses used a 2-sided type I error rate of 0.05 as the threshold for statistical significance and were performed with the use of JMP software (version 8.0; SAS Institute, Cary, NC).

Results

Five postoperative patellar fractures (1.51%) were identified during the observation period (Table 1). The mean age of these patients was 69.0 years (range, 64-77 years) at the time of TKA. Three fractures were identified within a year of the surgery. Of the 5 fractures, 4 occurred without any traumatic episode, and 2 of them were unexpectedly diagnosed by routine radiographic assessment. Four fractures were classified as type II in the Ortiguera and Berry Classification system, and the other was type III. Three components were the PS type, and the other 2 were the CR type.

Table 2. Characteristics of Participants

Characteristic	Fracture (−)		Fracture (+)		*P*
Participants	324		5		
Age (y)	61.7	(10.8)	69.0	(4.8)	.13
Insall-Salvati ratio	0.98	(0.15)	1.1	(0.15)	.29
Joint line change (mm)	7.8	(4.3)	10.8	(1.9)	.13
Patellar thickness (mm)	12.2	(1.6)	10.4	(1.8)	.01
Lateral release	158	(48.8%)	2	(40.0%)	.7
Implant					
PS	20	(6.2%)	3	(60.0%)	<.001
CR	304	(93.8%)	2	(40.0%)	

Data are expressed as mean (SD) or number of patients (%).

For the assessment of factors associated with patellar fracture, the baseline characteristics, intraoperative factors, and radiographic parameters were compared between the patients with and without a patellar fracture (Table 2). Patellar thickness was significantly lower in the group with than without fracture (mean, 10.4 vs 12.2 mm; $P = .01$), and the proportion with PS was significantly higher in the group with fracture ($P < .001$). Using the receiver operating characteristic curve, we determined that the cutoff point for the patellar thickness was 11 mm (area under the curve, 0.78; sensitivity, 80.0%; specificity, 67.9%). There was tendency of higher age (mean, 69.0 vs 61.7 years; $P = .13$) and greater joint line change (mean, 10.8 vs 7.8 mm; $P = .13$) in the fracture group. There was no tendency that 1 specific surgeon used specific type of prosthesis nor had higher prevalence of patellar fracture.

We constructed a multivariate logistic regression model to examine the correlation of the incidence of patellar fracture with patellar thickness and the use of PS components after adjusting for age and found that both patellar thickness and the use of the PS prosthesis were positively associated with the incidence of patellar fracture (Table 3).

We then reviewed the outcome of the fracture cases (Table 4). One type III fracture case was treated surgically by retrieving the patellar component, and the others were treated conservatively by applying knee braces for 2 to 3 weeks. No surgical procedures were performed in these cases. At the time of the latest follow-up, bone union was not observed in any of the cases, but all 5 patients reported that they had no pain and were ambulant; 2 of them used canes, and 3 did not. Extensor lag was less than 10° in all of the cases.

Discussion

Total knee arthroplasty with patellar resurfacing is generally favored in patients with RA [5-8], but we must be aware of the risk of postoperative patellar fracture. The reported prevalence of patellar fracture after TKA with patellar resurfacing ranges from 0.12% to 3.9%, which is higher than TKA without patellar resurfacing [3,9-12]. Little is known about patients with RA, but Grace and Sim [3] reported the incidence was 0.12% in patients with RA and 0.18% in patients with OA, with no significant difference between them. Scott et al [11] reported the incidence of postoperative patellar fracture

Table 3. Multivariate Logistic Regression Analysis for Odds Ratio and 95% Confidence Interval of the Risk Factors for Patellar Fracture

	Odds Ratio for Pain	95% CI	*P*
Implant: PS (vs CR)	30.30	3.85-311.68	.002
Patellar thickness	1.60	1.00-2.89	.049

Data were calculated by logistic regression analysis after adjustment for age and confounding. Abbreviation: CI, confidence interval.

Table 4. Treatment and Outcome in Each Fracture Case

Case	Treatment	Follow-Up (y)	Range of Motion (°)		Extensor Lag (°)	Bone Union	Pain	Walking Aid
			Before fracture	After fracture				
1	Knee brace	4	0-95	0-120	0	No	None	None
2	Knee brace	6	0-90	0-110	0	No	None	None
3	Knee brace	4	0-95	10-100	10	No	None	Cane
4	Knee brace	6	0-110	5-125	5	No	None	Cane
5	Patellar implant retrieval	10	0-90	0-90	0	No	None	None

to be 0.7% in patients with RA and 3.5% in patients with OA, suggesting a lower fracture risk in patients with RA. In our series, the prevalence of patellar fracture after TKA in female patients with RA was 1.5% (5/329 knees), which was within the range of the reported prevalence among the combined groups of patients with OA and RA.

Previous studies have reported risk factors for patellar fracture after TKA [13-15]. These include patient factors (RA, male sex, and osteoporosis), technical factors (excessive resection of patellar bone, lateral retinacular release, and revision surgery), and implant factors (PS type prosthesis, central peg, and cementless fixation). In the current study limiting the subjects to female RA patients with primary TKA, thinner postoperative patellar thickness and the use of a PS type of prosthesis were independently and significantly associated with patellar fracture. In addition, 4 (80%) of 5 fracture cases in our series occurred without a traumatic event. These findings imply that the increased patellofemoral contact stress, which results from using the PS type of prosthesis, and the reduced mechanical strength of the patella due to an excessive resection of the bone lead to stress fracture of the patella. However, we have to consider that there still have been an error of measurement using radiographs and that PS component could be preferred for patients with relatively severe deformity, which might have affected our result. In addition, it is possible that the higher frequency of patellar fractures in PS type of prosthesis is specific for the Japanese patients with a relatively wide intercondylar notch relative to the medial-lateral width of the femur.

In addition to these factors, there was a tendency of higher age and joint line change in the group with fracture. Excessive joint line change may exert an effect on the tibial-patellofemoral mechanical axis and increase the stress on the patella, as in the report by Figgie et al [4], where they found that an excessive joint line change (>8 mm) in TKA was associated with poor clinical results.

Ortiguera and Berry [10] proposed a classification system for postoperative patellar fracture. Using this system, in our series, 4 fractures (80%) were type II (implant intact/extensor mechanism disrupted), and 1 was type III (implant loose). In previous reports, type II fractures were relatively rare (15%-22%) [9,10,16], which is different from our cases. Therefore, our findings might reflect a special characteristic of female patients with RA.

The choice of treatment strategy for patellar fractures after TKA is controversial, but previous reports have tended to favor conservative treatment because of the considerable possibility of nonunion and infection after operative treatment [9,10,16,17]. Chalidis et al [17], in a systematic review, indicated that the mean nonunion rate after internal fixation with a tension-band technique or cerclage wire was 92%, with poor results in most cases. We treated 4 type II fractures nonoperatively with a knee brace for 2 to 3 weeks, and 1 type III fracture was treated operatively by retrieving the patellar component. Bone union was not observed in any case, yet all of these patients were ambulant, without reported pain, and exhibited only limited extensor lag (<10°) at the time of the last follow-up. Our clinical experience supports nonoperative treatment option.

In summary, we have described the prevalence, risk factors, and outcome of patellar fractures after primary TKA with patellar resurfacing in female patients with RA. Our analysis suggests that the residual bony thickness of the patella should not be less than 11 mm and that PS-type prostheses should be avoided if possible, especially in patients with a thin patella. In the event that a fracture does occur, conservative treatment seems a favorable choice.

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