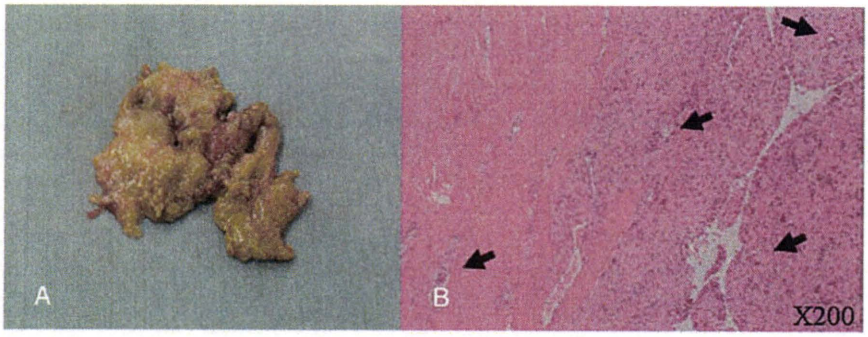

Fig. 3. Synovial granuloma tissue retrieved from the joint capsule (A). Polyethylene wear particles are present throughout the retrieved synovial tissues. Arrows indicate polyethylene particles encapsulated by foreign body giant cells (B).

area of dimensional change was identical to the contact position of femoral condyles defined by earlier shape-matching investigations (data not shown). Minor wear of the top of the post was observed, representing a finding that is reportedly unique to an open-box design and resulting from cement extrusion into the box (Fig. 4B). Prominent findings were a double-concave deformation of the post, suggestive of gradually accumulated dimensional changes resulting from cam/post contact (Fig. 4C). The upper concave surface may have resulted from *seiza*-style sitting with the knee in greater than 145° of flexion, whereas the lower concave surface may have occurred with 60° to 145° flexion. At the 6-month follow-up after insert replacement, joint effusion had disappeared; and the patient had returned to a floor-sitting lifestyle. Clinical scoring according to the Hospital for Special Surgery score had improved from 58 to 95.

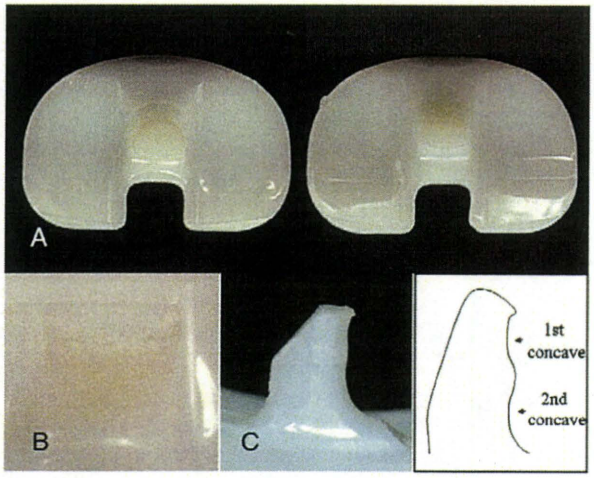

Fig. 4. Polyethylene insert retrieved 7 years postoperatively. Tibiofemoral surfaces display burnishing and dimensional change (ie, creep) (A). Polyethylene post shows abrasion on the top (B) and double-concave deformation in the posterior part suggestive of marking from cam/post contact (C). Schematic representation clearly shows 2 distinct concave surfaces (C, right panel).

Discussion

An earlier study proposed 2 potential risks associated with very deep flexion for the same type of implants used in the present patient [3]. First, large tibial rotation in deep flexion might cause the lateral condyle to overleap the posterior border of the polyethylene insert, leading to breakage of the posterior rim. Fortunately, this did not occur in the present patient, as the tibiofemoral contact position was located anteriorly and internal rotation of the tibia was small. Second, the tibiofemoral articulating surface reportedly separates in more than half of knees at flexion greater than 130°, whereas the cam/post remains in contact even at flexion greater than 130° in most patients [3]. Theoretically, cam/post contact during *seiza*-style sitting might increase the risk of post breakage because the site of concave deformation is moving to the upper part of the post with increasing flexion of the knee. This might arguably represent a limitation of posterior cruciate ligament-sacrificing prostheses with a cam/post design facing the risk of post wear or breakage during *seiza*-style sitting.

Deeply flexed postures increase the risk of polyethylene wear, as tibiofemoral contact occurs at the superior aspect of the femoral condyles in very deep flexion, where contact areas are small. Although histopathology of proliferative synovia revealed substantial numbers of polyethylene particles surrounded by foreign body giant cells, pathologic associations between these particles and continuous joint effusion remained unclear because a 7-year–old well-functioning TKA will inevitably present with certain amounts of wear particles within periprosthetic granulation tissue and surrounding synovia. However, we have previously encountered a case involving a highly damaged polyethylene insert presenting with wear particle–induced synovitis and continuous joint effusion, ultimately developing gigantic popliteal synovial cyst [4]. If such a case were left untreated, accumulation of inflammatory cytokines in joint fluid and increased

intraarticular pressure might result in loosening of the prosthesis via periprosthetic osteolysis. In the present case, given that polyethylene insert revision alone soon resulted in the resolution of the joint effusion and limitation of deep flexion, we believe that joint effusion was at least partially attributable to wear particle–induced synovitis.

The risk of wear or fracture of the post has already been highlighted in posterior stabilized implants with an open-box design. Anterior post impingement to the femoral notch occurs with the knee in extension and occasionally causes fracture of the post. This type of impingement has been thoroughly investigated and implicated in increased tibial slope and/or flexed position of the femoral component [5-7]. Conversely, posterior post impingement to the cam reportedly occurs at knee flexion greater than 80° [8], theoretically contributing to the generation of wear particles and/or damage to the post, as a past in vitro experiment showed that cam/post contact force increases with increasing knee flexion [9]. To the best of our knowledge, no previous studies have suggested that very deep flexion can cause post fracture; however, the present case illustrates that repeated very deep flexion, such as in *seiza*-style sitting, may potentiate the risk of post wear and breakage. Future designs for posterior stabilized mechanisms should be awaited to ensure a safe floor-sitting lifestyle, particularly for use in Asian and Middle Eastern countries.

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Original article

Rheumatoid arthritis: a risk factor for deep venous thrombosis after total knee arthroplasty? Comparative study with osteoarthritis

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Abstract

Background. Recent advances in the understanding of blood coagulation processes favor an inflammatory basis for thrombotic events. In this study, thrombotic risk after total knee arthroplasty (TKA) was assessed and compared between patients with rheumatoid arthritis (RA) and those with osteoarthritis (OA).

Methods. Subjects comprised 199 patients (238 knees) with RA and 156 patients (169 knees) with OA. Serum D-dimer levels were measured before and after the operation. Low-dose unfractionated heparin was given for 7 days when patients had a history of previous venous thromboembolism or had a D-dimer level or ≥10 μg/ml of D-dimer on postoperative day 1. Doppler ultrasonography (DUS) was routinely performed preoperatively and on postoperative day (POD) 7 for diagnosing a deep venous thrombosis (DVT).

Results. D-dimer levels on PODs 0, 1, and 7 were, respectively, 4.6, 37.2, and 11.2 μg/ml for RA and 1.8, 42.3, and 13.6 μg/ml for OA. The incidence of DUS-confirmed DVT was 20.6% in the RA group and 43.2% in the OA group, indicating a much higher incidence of postoperative DVT in OA patients ($P < 0.001$). Interestingly, when patients taking nonsteroidal antiinflammatory drugs (NSAIDs) or those >65 years of age were excluded, the incidence of DVT was comparable in the RA and OA groups. Symptomatic pulmonary embolism and DVT occurred in two and one OA patients and in one and two RA patients, respectively, with one post-discharge DVT included in each group.

Conclusions. The present study revealed that the incidence of DVT following TKA was significantly lower in RA patients than in those with OA. However, when the patients were matched for age and NSAID use, the incidence of DVT was equivalent in the two groups. These findings may allow us to reconsider a prophylactic regimen for venous thromboembolism in patients with RA.

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Introduction

Venous thromboembolism (VTE) is a potentially life-threatening complication in patients undergoing total hip arthroplasty (THA) or total knee arthroplasty (TKA). VTE clinically incorporates signs and symptoms of two interrelated but distinct clinical conditions: deep vein thrombosis (DVT) and pulmonary embolism (PE). The seventh American College of Chest Physicians (ACCP) guidelines for VTE,[1] which are widely accepted evidence-based guidelines concerning the use of VTE prophylaxis, define THA and TKA as having the highest risk of postoperative VTE. The incidence of VTE has so far been considered lower in Japan than in Europe or North America, and VTE has been underdiagnosed and undertreated over the past three decades. However, the incidence is currently increasing and has reached 22.6% for THA and 48.6% for TKA,[2] resulting in increased awareness of the need for VTE prophylaxis in Asian countries.

To date, various risk factors predisposing to VTE have been identified and can be applied to the screening of patients for increased VTE risk prior to surgery.[3] These proven factors comprise heart failure, obesity, age >75 years, history of VTE, varicose veins in the lower extremities, and estrogen therapy; they also include certain inflammatory states, such as certain neoplasms,[4,5] inflammatory bowel disease,[6,7] and septicemia.[8,9]

At present, joint arthroplasty is a promising surgical intervention applicable to patients with several inflammatory arthritides, such as rheumatoid arthritis (RA), ankylosing spondylitis, and psoriatic arthritis. Indeed, these inflammatory arthritides account for a substantial proportion of the primary reasons for performing joint arthroplasty. However, whether inflammatory arthritis is a potential candidate predisposing patients to postoperative VTE remains controversial.

In fact, contradictory results on the association between RA and VTE have been reported in the litera-

ture. The main scenarios supporting accelerated thrombosis in RA patients show that active RA exhibits hypercoagulability with reduced fibrinolysis[10] and elevated levels of autoantibodies such as anti-cardiolipin antibodies and anti-phospholipid antibodies.[11-13] Conversely, reports advocating a lower thrombotic risk in RA patients have noted that frequent administration of nonsteroidal antiinflammatory drugs (NSAIDs), younger age distribution, and lower body mass index (BMI) in RA patients may decrease the incidence of VTE.[14-16] The present study assessed and compared thrombotic risk after TKA between patients with RA and those with noninflammatory arthritis, osteoarthritis (OA), to clarify whether RA represents a predisposing factor to VTE following joint arthroplasty.

Materials and methods

Patient characteristics

A consecutive series of 425 knees from 373 patients who underwent primary TKA between October 2003 and June 2007 were enrolled. Among them, 18 knees from 18 patients were excluded from the study for the following reasons: Anticoagulation prophylaxis was contraindicated in eight patients owing to the presence of high bleeding risk or renal impairment; three refused routine anticoagulation therapy; and seven refused postoperative laboratory testing on a routine basis as required by the study protocol. As a result, the RA group comprised 238 knees from 199 patients, and the OA group comprised 169 knees from 156 patients.

Patient demographic characteristics in the two groups are shown in Table 1. The mean age at the time of TKA was 59.9 years (range 25–84 years) in the RA group and 74.2 years (range 40–88 years) in the OA group. The risk of VTE in each patient was individually assessed based on the presence of proven risk factors, as follows: heart failure; obesity (BMI ≥ 30); age >75 years; history of VTE; varicose veins in the lower extremities; use of estrogen therapy; use of warfarin; specific disease conditions including diabetes mellitus, neoplasm, and inflammatory bowel disease. The mean number of risk factors per patient was 1.06 for the RA group and 1.79 for the OA group, indicating a significantly higher VTE risk in the OA group than in the RA group.

As blood rheological properties are closely related to venous circulation and potentially affect susceptibility to VTE, preoperative levels of hemoglobin and hematocrit were measured. The mean values of hemoglobin and hematocrit were, respectively, 12.3 g/dl and 35.3% in the OA group and 11.3 g/dl and 32.5% in the RA group. There was no statistically difference between the two groups (Table 1).

Regarding preoperative oral administration of NSAIDs, in the RA group, 131 patients used NSAIDs daily, 24 patients used them on demand, and 44 patients did not use NSAIDs. In contrast, in the OA group, 9 patients used NSAIDs daily, 44 patients used them on demand, and 103 patients did not use NSAIDs. Anti-tumor necrosis factor (TNF) inhibitors were administered to 16 patients in the RA group (etanercept, $n = 4$; infliximab, $n = 12$) and no patients in the OA group.

As patient age, BMI, frequency of NSAID use, and number of risk factors at the time of TKA differed significantly between the RA and OA groups (Table 1), patients taking NSAIDs and those ≤65 years of age were excluded from each group, and statistical analyses were performed again. These exclusions were made because the use of NSAIDs and patient age reportedly affect the incidence of VTE.[16] Demographic data for the two groups after these adjustments were made are shown in Table 2.

The study was approved by the institutional human subjective research committee, and informed consent was obtained from all patients participating in the study.

Antithrombotic protocol

Serum D-dimer levels were measured on postoperative days (PODs) 0, 1, and 7. When patients displayed a D-dimer level of ≥10 μg/ml on POD 1, low-dose unfractionated heparin (LDUH) (5000 units) was given subcutaneously three times a day from POD 2 to POD 8. An equivalent dose of LDUH was given to high-risk patients with either a history of previous VTE or three or more risk factors.

Doppler ultrasonography (DUS) was routinely performed in all patients preoperatively and on POD 7 for diagnosing DVT. Warfarin was administered orally to patients with DUS-confirmed DVT, starting on POD 7 and continuing for 3 months. Patients were followed for symptomatic VTE until ≥3 months after TKA.

Bleeding complications were recorded as described previously.[17] They were classified as "major" if clinically overt (clinically apparent bleeding or signs and/or symptoms suggestive of bleeding with confirmatory imaging studies such as ultrasonography or computed tomography) and meeting one or more of the following criteria: involvement of a critical site (intracranial, retroperitoneal, intraspinal, intraarticular, gastrointestinal, pericardial); bleeding index ≥2.0 (calculated as the baseline hemoglobin level, in grams/liter, minus the hemoglobin level at the end of treatment plus the number of units of packed red blood cells or whole blood transfused); need for medical or surgical intervention; fatal bleeding.

Table 1. Demographic characteristics of patients with RA and OA

Characteristic	RA	OA
No. of knees	238	169
No. of patients	199	156
Age (years) (range)*	59.9 (25–84)	74.2 (40–88)
Sex (no. of patients/knees)		
Male	20/17	17/16
Female	218/182	152/140
BMI (range)*	21.8 (14.0–33.9)	25.0 (16.2–33.3)
No. of knees, by no. of risk factors		
0	114	35
1	57	44
2	18	44
3	38	24
4	9	12
5	2	10
Mean*	1.06	1.79
Medications (no. of knees/patients)		
NSAIDs		
None*	47/44	112/103
On demand	32/24	48/44
Daily*	159/131	9/9
Oral steroid*	82/70	0/0
Anti-TNF inhibitor*	18/16	0/0
Preoperative levels of blood rheological parameters[a]		
Hemoglobin (g/dl)	11.3 ± 1.8	12.3 ± 1.5
Hematocrit (%)	32.5 ± 4.6	35.3 ± 3.4
CRP level (mg/dl)[a]		
Preoperative*	1.27 ± 1.87	0.34 ± 0.88
Postoperative day 1	4.83 ± 2.73	4.54 ± 2.84

RA, rheumatoid arthritis; OA, osteoarthritis; BMI, body mass index; NSAIDs, nonsteroidal antiinflammatory drugs; TNF, tumor necrosis factor

* $P < 0.05$, RA vs. OA

[a]Values are expressed as the mean ± SD

Table 2. Demographic characteristics of patients matched for age and NSAIDs non-use

Characteristic	RA	OA
No. of knees	42	102
No. of patients	39	95
Age (years), mean (range)	75.0 (65–84)	75.7 (65–88)
Sex (no. of knees/patients)		
Male	5/4	12/12
Female	37/35	90/83
BMI (range)	23.4 (18.8–29.4)	24.8 (16.8–33.3)
No. of knees, by no. of risk factors		
0	7	14
1	15	30
2	4	35
3	15	13
4	1	7
5	0	4
Mean	1.71	1.82
Medications (no. of knees/patients)		
Oral steroid*	8/6	0/0
Anti-TNF inhibitor	2/2	0/0
CRP level (mg/dl)[a]		
Preoperative	0.39 ± 0.74	0.28 ± 0.45
Postoperative day 1	4.99 ± 2.78	4.78 ± 1.83

* $P < 0.05$, RA vs. OA

[a]Values are expressed as the mean ± SD

Statistical analysis

The RA and OA groups with and without adjustment for age and NSAID use were compared for the following: age; BMI; rate of NSAID use; incidence of DUS-confirmed asymptomatic DVT; incidence of symptomatic DVT or PE; incidence of bleeding complications; rate of LDUH use; and serum D-dimer levels on PODs 0, 1, and 7. Statistical analyses were performed using Student's *t*-test for continuous variables and a χ^2 contingency table for dichotomous values. $P < 0.05$ was considered statistically significant.

Results

Time course of changes in serum D-dimer levels

Serum levels of D-dimer on PODs 0, 1, and 7 were, respectively, 4.6 ± 0.51, 37.2 ± 2.6, and 11.2 ± 0.46 μg/ml for RA and 1.8 ± 0.41, 42.3 ± 5.5, and 13.6 ± 1.2 μg/ml for OA (Fig. 1). Serum D-dimer levels were thus significantly higher in the RA group than in the OA group preoperatively ($P < 0.05$), whereas similar time courses of D-dimer levels were seen for the two groups postoperatively, although tending to be slightly higher in the OA group than in the RA group.

Incidence of VTE

Preoperatively, DUS-confirmed DVT was found in 21 patients (8.8%) in the RA group and 19 patients (11.2%) in the OA group, with no significant difference between groups (Table 3). On POD 7, the incidence of DUS-confirmed DVT was 20.6% in the RA group and 43.2% in the OA group, indicating more frequent DVT in the presence of OA than in RA ($P < 0.001$). Proximal DVT was identified in eight RA patients (3.3%) and seven OA patients (4.1%), showing no significant difference. All patients were available for follow-up for ≥3 months after TKA and were checked for development of symptomatic VTE. During the first 3 months after TKA, symptomatic PE was found in two patients in the OA group and one patient in the RA group, and symptomatic DVT was found in two patients in the RA group and one patient in the OA group, including one case of postdischarge DVT in each group.

According to the existing literature dealing with comparative analysis of DVT risk between RA and OA, the incidence of DVT has been considered low for RA patients potentially because of the frequent administration of NSAIDs and younger age distribution among patients with RA.[16] Patients using NSAIDs or who were

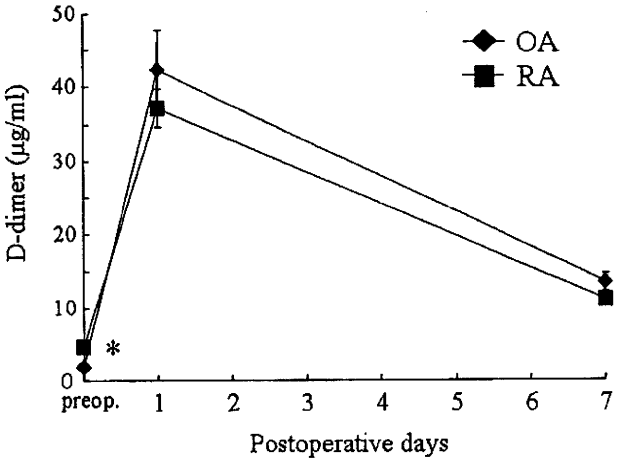

Fig. 1. Time course of plasma D-dimer levels after total knee arthroplasty. Data are given as the mean ± standard deviation. *Preop.*, preoperative. *$P < 0.05$, rheumatoid arthritis (*RA*) vs. osteoarthritis (*OA*)

Table 3. Incidence of VTE and bleeding complications within first 3 months after TKA

Parameter	All patients		Patients matched for age and NSAIDs non-use	
	RA ($n = 238$)	OA ($n = 169$)	RA ($n = 42$)	OA ($n = 102$)
Asymptomatic DVT (no. of knees)				
Preoperative	21 (8.8%)	19 (11.7%)	4 (9.5%)	10 (9.8%)
Postoperative day 7	49 (20.6%)*	73 (43.2%)	16 (38.1%)	43 (42.2%)
Proximal DVT	8 (3.3%)	7 (4.1%)	2 (4.8%)	4 (3.9%)
Symptomatic DVT (no. of knees)				
In-hospital	1	0	0	0
After discharge	1	1	1	1
Symptomatic PE (no. of knees)	1	2	0	1
LDUH use (%)	67.7	72.5	78.6	72.5
Major bleeding (no. of knees)	1	2	0	1

VTE, venous thromboembolism; TKA, total knee arthroplasty; DVT, deep vein thrombosis; PE, pulmonary embolism; LDUH, low-dose unfractionated heparin
*$P < 0.001$, RA vs. OA

≤65 years of age were therefore excluded from each group to adjust the patient demographics between groups and elucidate the precise effects of the chronic inflammation of RA on the development of VTE. After this adjustment, no significant differences were identified between the RA and OA groups regarding age, sex, BMI, or number of preexisting risk factors for VTE (Table 2).

Interestingly, the incidence of DVT was 38.1% for RA and 42.2% for OA after the adjustments, suggesting that the incidence of DVT was quite similar in the two groups; thus, RA itself does not appear to represent a predisposing factor for DVT. In addition, regarding symptomatic VTE, the incidences of PE and DVT were not significantly different (Table 3).

Approximately 70% of patients in our TKA series received LDUH during the postoperative course according to our screening protocol of anticoagulation therapy (Table 3). Major bleeding complications during LDUH administration were seen in two patients with OA (gastrointestinal bleeding, $n = 1$; surgical site bleeding, $n = 1$) and one patient with RA (gastrointestinal bleeding).

Discussion

As total joint arthroplasties, such as TKA and THA, are becoming promising surgical interventions for treating joint destruction associated with RA and related inflammatory arthropathies, important issues facing the patients undergoing total joint arthroplasty are increasingly highlighted, including postoperative VTE. TKA and THA have been defined as carrying the highest thromboembolic risks according to accumulated evidence, such as the finding that the incidence of DVT after joint arthroplasty can reach 50%, and fatal PE occurs in 1%–6% without thromboprophylaxis.[18] These data have been derived predominantly from patients with OA, however, and the precise thromboembolic risk in patients with RA remains poorly understood.

To date, certain studies dealing with postoperative VTE risk in patients with RA have documented that the incidence of DVT is 3–10 times lower in patients with RA than in patients with OA.[14,15] Another retrospective study of the incidence of postdischarge VTE after joint arthroplasty reported that only 1 of 103 patients with RA developed symptomatic DVT during a 1-year follow-up.[16] These studies reached the identical conclusion that the decreased incidence of symptomatic VTE in patients with RA was attributable to frequent use of NSAIDs with the resulting antiplatelet activity. However, those studies appear to include the following drawbacks: (1) the studies were not prospective investigations; (2) the studies focused only on symptomatic VTE and did not include asymptomatic VTE; and (3) the precise effects of the chronic inflammation in RA on developing VTE were not clarified, as most RA patients used NSAIDs preoperatively. The present study therefore prospectively investigated the incidence of both symptomatic and asymptomatic DVT in patients with RA undergoing TKA, with particular emphasis on comparison between patients with RA and OA, none of whom were using NSAIDs.

According to the results from all patients enrolled, patients with RA displayed significantly higher D-dimer levels preoperatively, reflecting accelerated fibrin formation and fibrinolysis in the preoperative phase due to constitutive inflammation. Conversely, postoperative D-dimer levels were not significantly different between patients with RA and OA. As expected, the incidence of DUS-confirmed DVT on POD 7 in patients with OA was double that in patients with RA, potentially because in our RA series approximately 78% of patients were orally administered NSAIDs both pre- to postoperatively. Interestingly, when patients taking NSAIDs or ≤65-years-old were excluded, the incidence of DUS-confirmed DVT was comparable between the RA and OA groups. Whether chronic inflammatory diseases such as RA are associated with the development of VTE after joint arthroplasty thus remains controversial.

Historically, inflammation has had little to do with the coagulation response; and a traditional view was that the blood coagulation pathway is simply triggered when tissue factor derived from the cell surface of leukocytes, particularly monocytes, comes in contact with factor VII/VIIa in the blood.[19,20] During the 1990s, however, the picture changed in light of new observations that inflammatory mediators such as endotoxin, tumor necrosis factor-α (TNF-α), and CD40 ligand play crucial roles in the activation of tissue factor.[21–23] Recent studies support an inflammatory basis for the blood coagulation process,[24] and chronic inflammatory conditions may shift the hemostatic balance to favor the activation of coagulation, as has been documented clinically in inflammatory bowel diseases including ulcerative colitis and Crohn's disease.[6,7] Although the best known scenario of inflammation-induced hypercoagulation is the induction of tissue factor, other possible mechanisms can be considered, including impairment of the protein C anticoagulant pathway by down-regulating the expression of thrombomodulin and endothelial cell protein C receptor on endothelial cells,[25,26] and up-regulating levels of plasminogen activator inhibitor (PAI)-1 and subsequent impaired ability to remove thrombus (i.e., fibrinolysis).[27] Mounting evidence has proven elevated levels of TNF-α and PAI-1 in patients with RA,[28,29] and these patients are prone to thrombotic complications after joint arthroplasty. However, according to the

present study, the incidence of VTE after TKA is basically equivalent between RA and OA patients despite the standardization of risk factors for VTE in the two groups. At present, we believe that these unexpected results can be explained by the fact that (1) the inflammation of RA can be tightly controlled using anti-TNF inhibitors and (2) the pre- and postoperative C-reactive protein (CRP) levels of the RA patients were regulated to levels similar to those in OA patients (Tables 1, 2).

As hemoglobin and hematocrit levels tend to be low in patients with RA, blood rheology should not be overlooked in regard to DVT pathogenesis when considering DVT risk in RA patients. However, whether blood rheology affects a patient's susceptibility to postoperative DVT remains unclear despite the close relation between blood rheological properties and venous circulation. Hemoglobin and hematocrit levels do not appear to have been defined as risk factors for DVT in previous studies.[30,31] The present study, however, could not disregard the influence of these two parameters, as values tended to be lower in RA patients than in OA patients and could not be matched during comparisons of RA and OA. Whether blood rheology represents an alternative etiology for DVT is a potential subject for future studies.

In our TKA series, the overall incidence of DUS-confirmed DVT was 20.6% in the RA group and 43.2% in the OA group, indicating a much lower incidence of postoperative DVT in RA patients. A recent study showed that the incidence of symptomatic VTE in patients with RA undergoing joint arthroplasty was low owing to daily administration of NSAIDs,[16] supporting the present findings. Even though lower DVT risk in RA was attributable to younger age and higher frequency of NSAID usage at the time of TKA — rather than to the disease itself — surgeons should pay close attention to the prophylactic use of anticoagulant therapies for thromboembolic events after TKA in patients with RA.

Finally, our findings must take into consideration three major limitations of this study. First, a multiple regression analysis should have been used to analyze the effects of all independent variables as potential risk factors for VTE. However, in our cohort, LDUH was administered only to the patients with increased risk of VTE based on assessments of their preoperative risk score or their D-dimer level, which created a bias regarding the indication for anticoagulant therapy after TKA in our cohort. As use of anticoagulant therapy is considered to be the most critical factor influencing the incidence of VTE, it is worthless to analyze risk factors of VTE in this cohort. In fact, when a stepwise multiple linear regression analysis was performed in this cohort, use of LDUH was paradoxically defined as a significant risk factor of VTE with the largest odds ratio because LDUH was used in the patients with a high VTE score.

Second, the precise effects of NSAIDs on the incidence of VTE following TKA remain unclear as the present study did not directly confirm whether the reduced incidence of VTE in RA patients was attributed to frequent administration of NSAIDs or the disease itself. The patients should be randomized to use of NSAIDs preoperatively in both RA and OA cohorts, which is a potential subject for future study.

Third, because one investigative group reported that oral steroid use is one of the risk factors for postoperative VTE,[32] we should have elucidated whether steroid use affected the incidence of VTE in our cohort. However, the type, dosage, and duration of steroid use varied considerably from case to case; and the net steroid usage could not be explained by daily steroid dosage at the time of examination. Further studies, including a randomized controlled trial, on the use of NSAIDs or steroid in larger cohorts of RA patients are needed so we can better understand the true magnitude of VTE risk following TKA in patients with RA.

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Extension Limitation in Standing Affects Weight-Bearing Asymmetry After Unilateral Total Knee Arthroplasty

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Abstract: The aim of this study was to evaluate weight-bearing condition after unilateral total knee arthroplasty (TKA) during standing and to examine whether the condition affects knee kinetics during gait in both limbs. Twenty-five patients, who underwent unilateral TKA for symptomatic bilateral osteoarthritis and who were on average 74 years old, participated. As a result, operated limbs became dominant in 80% of the patients. The other 20%, who had lack of knee extension during standing, showed more weight bearing in nonoperated knees. Furthermore, extension limitation in the operated knee in standing led to mechanical overload in the contralateral limb during gait. Therefore, to avoid progression of the osteoarthritis in the contralateral knee, it is important to acquire full extension in the operated knees during standing after unilateral TKA. **Keywords:** unilateral total knee arthroplasty, weight-bearing asymmetry, standing, gait analysis, extension limitation, quadriceps muscle strength.

Severe knee osteoarthritis (OA) often limits the elderly people to perform normal activities of daily living. Symptomatic knee OA is found in approximately 14.4% of men and 28.4% of women older than 45 years, and 87% of knee OA occurs bilaterally [1,2]. Total knee arthroplasty (TKA) has traditionally been performed as an effective treatment for these patients, by relieving pain, restoring function, and correcting deformity [3,4]. Gait analysis is widely used to evaluate dynamic function of both osteoarthritic and replaced knee joint [5-7]. As described in the previous gait analysis studies, abnormal joint loading is indicated in patients with knee OA [8-10]. The patients with medial knee OA have increased knee adduction moment during walking. According to previous studies, pain relief was accompanied by knee adduction moment after use of nonsteroidal anti-inflammatory drug in patients with knee OA [11-13]. In addition, Hurwitz et al [11] showed that decreases in pain were associated with an increase in knee joint loading during level walking and indicated that the change in pain levels was inversely correlated with the change in knee joint loading. Therefore, pain could be a protective mechanism against increased joint loads; and subjective pain may result in reduced loading of the affected joint. Thus, increased joint loads should be observed after TKA comparing with those of contralateral OA because pain level is reduced. On the other hand, it is possible that subjective pain in contralateral OA knee can be frequently reduced after unilateral TKA. Although we often experienced this phenomenon, little attention has been paid to evaluate weight-bearing condition in both limbs after the surgery.

We hypothesize that the knee joint after TKA would act as a dominant limb and have more weight bearing than contralateral nonoperated OA knee in relaxed standing because compensatory mechanics against painful OA knee is basically observed. The aim of this study was to evaluate weight-bearing condition in both limbs after unilateral TKA during standing and to examine whether the surgery affects the loading rate and other gait parameters in contralateral OA knee using gait analysis.

Materials and Methods

Participants and Gait Analysis System

Twenty-five patients (22 women and 3 men), who underwent unilateral TKA for bilateral symptomatic knee osteoarthritis and who were 67 to 84 years old

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Table 1. Demographic Data of 25 Patients Undergoing Unilateral TKA (Mean ± Standard Deviation)

	Patients (n = 25)
Age	74.1 ± 5.5
BMI (kg/m^2)	26.0 ± 3.0
Sex (female/male)	22/3
Implant (CR Flex/LPS Flex)	6/19
Follow-up period (mo)	14.7 ± 9.4

(mean, 74 years), participated in the current study. Cruciate-retaining or posterior-stabilized component design (NexGen CR Flex or LPS Flex, Zimmer, Warsaw, IN) were used by a single surgeon (TO). We confirmed that replaced knee acquired full extension after the procedure in the operation room. Patients underwent a standard rehabilitation program that consisted of early range of motion and weight-bearing exercises as tolerated. Radiographic grades of knee OA in nonoperated knees were at least grade 3 severities according to the Kellgren-Lawrence grade [14], including 7 knees of grade 3 and 18 knees of grade 4. Patients who had any symptoms in either the hip or ankle joint were excluded. Demographic data of 25 patients are presented in Table 1.

After an informed consent, all subjects were tested at our gait laboratory using 6 retroreflective markers, a 5-camera system (120 frames per second; Pro-reflex, Qualisys, Gothenburg, Sweden), and a force plate (sample frequency, 120 Hz; Type 4060-10, Bertec, Columbus, OH) at an average of 15 (4-36) months after surgery. Six markers were placed at the lateral aspect of the iliac crest, greater trochanter, lateral joint line of the knee, lateral malleolus, lateral aspect of the calcaneus, and head of the fifth metatarsal [15]. Clinical assessment was done using Hospital for Special Surgery (HSS) score, and passive range of motion was examined. All methods and procedures were also approved by our institution's ethics committee.

Motion Analysis

The patients performed relaxed standing, placing 1 foot on a force plate for 5 seconds until subjects became stable and relaxed (Fig. 1A); and thereafter, they were asked to walk on a level floor for about 10 m at their preferred speed. Relaxed standings were measured in each patient twice. Walking trials included warm-ups, and the trials were measured several times until clear contact with the force plate was achieved in each trial. Because there is a single force plate in the laboratory, the measurements for each leg were undertaken independently. The knee kinetics was calculated using an inverse dynamics approach [16].

Evaluation of Loading Asymmetry

During relaxed standing, knee resultant force (percentage of body weight [%BW]) was calculated on bilateral knees of all patients. Definition of dominant side limb was based on the evaluation of loading asymmetry according to these forces: TKA dominant, knee resultant force was greater on TKA side than OA side; or OA dominant, knee resultant force was greater on OA side than TKA side.

Analysis of Factors Affecting the Loading Asymmetry

To analyze the factors that affect the weight-bearing condition in both limbs, patients' backgrounds were compared between TKA-dominant group (group A) and OA-dominant group (group B). Because side-to-side differences of weight distribution in standing would lead to the gait asymmetry as previously described in the literature [17,18], the following parameters were also evaluated in each group: knee flexion angles (degrees) in standing and at heel strike on each knee, peak values of net knee adduction and extension moment (%BW Height) on each knee, and maximum axial knee loading rate (%BW per second) on OA knees during gait. *Maximum axial loading rate* was defined as maximum slope of the axial force at the knee during first 10% of stance phase. The *axial force at the knee* was defined as the intersegmental resultant force at the knee resolved along the long axis of the shank, taking into account the ground reaction force, the weight of the shank, and the inertial forces (Fig. 1B) [19].

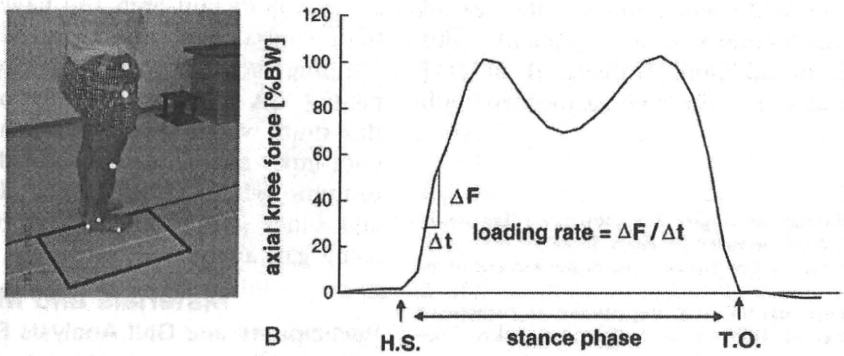

Fig. 1. (A) Subjects performed relaxed standing, placing 1 foot on a force plate, and level walking thereafter. (B) *Maximum axial loading rate* (%BW per second) was defined as maximum slope of the axial force during first 10% of stance phase.

Statistical Analysis

An average value of 2 trials was calculated. Statistical difference between TKA and OA knees in each group was evaluated using Wilcoxon t test. In addition, Mann-Whitney U test was used to determine the differences between groups in TKA or OA knees. Categorical valuables were analyzed by χ^2 test or Fisher exact test. P values less than .05 were considered as significant. All statistical analyses were done with the use of SPSS Version 11 for Microsoft Windows (SPSS, Chicago, IL).

Results

Weight-Bearing Asymmetry

Weight-bearing asymmetry was seen among the patients, as 20 patients were allocated to TKA dominant (group A) and 5 patients were OA dominant (group B). In group A, the averages of knee resultant forces (%BW) were 53.4 ± 9.8 on TKA side and 34.8 ± 6.7 on OA side. On the contrary, those were 39.1 ± 6.7 on TKA side and 50.0 ± 6.3 on OA side in group B. Each patient in both groups had relatively large side-to-side difference that was more than 5%BW (Table 2).

Factors Affecting Asymmetrical Loading

Concerning the demographic data, there were no statistical differences between the groups, including age, body mass index (BMI), total HSS score, passive range of motion, and other categorical valuables (Table 2). When comparing pain scores of HSS on TKA side in both groups, there was no difference, as the scores were 28.7 ± 2.3 in group A and 27.0 ± 4.4 in group B. Furthermore, pain scores on OA side were 21.8 ± 3.8 in group A and 23.0 ± 5.7 in group B; and those were not significantly different between the groups.

Results of knee flexion angles during relaxed standing are presented in Fig. 2. In group A, operated knees were significantly more extended than OA knees during relaxed standing, although operated knees were significantly more flexed than OA knees in group B.

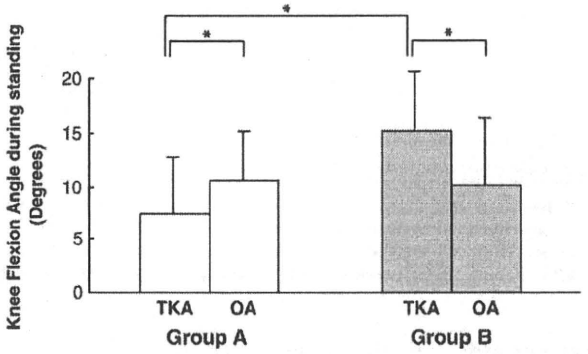

Fig. 2. Knee flexion angle (degrees) during relaxed standing in each group (*P <05).

Particularly, operated knees had less knee extension in group B than in group A.

Knee flexion angles at heel strike were not significantly different between the knees in each group (Table 3), although the angle on TKA side in group B was relatively larger than that in group A. Net knee adduction and extension moment are also presented in Table 3. The TKA side had less net knee adduction moment than the OA side, but the moments were not significantly different between TKA knees or OA knees in both groups. Net knee extension moments in group B were significantly smaller than those in group A, when comparing the moments between the TKA knees or OA knees. Maximum axial knee loading rate (%BW per second) on OA side during gait is found in Fig. 3. Those on OA knees in group B were significantly larger than those in group A. We confirmed that all the data obtained from gait analysis in the current study were reproducible.

Discussion

Our hypothesis that TKA side has dominant loading in relaxed standing was confirmed in 20 of 25 patients (80%). Although many studies have concentrated on the role of high flexion in TKA [20-22], few have

Table 2. Patient Data in Each Group (Mean ± Standard Deviation)

	Group A (n = 20)		Group B (n = 5)		Statistical
	TKA Side	OA Side	TKA Side	OA Side	Significance
Knee resultant force in standing (%BW)	53.4 ± 9.8	34.8 ± 6.7	39.1 ± 6.7	50 ± 6.3	NS
Age	74.3 ± 5.2		72.8 ± 6.3		NS
BMI (kg/m^2)	26.1 ± 3.4		25.9 ± 1.3		NS
Sex (female/male)	19/1		3/2		NS
Implant (CR Flex/LPS Flex)	4/16		2/3		NS
Follow-up period (mo)	14.5 ± 9.4		15.7 ± 9.7		NS
Radiographic OA grade (grade 3/grade 4)		5/15		2/3	NS
Total HSS score	91 ± 4.2	81 ± 12.1	90.3 ± 6.7	82.5 ± 8.3†	
HSS pain score	28.7 ± 2.3	21.8 ± 3.8*	27 ± 4.4	23 ± 5.7†	
Passive range of motion (extension)	1.3 ± 3.7	5.2 ± 8.5	3.3 ± 6.9	4.0 ± 6.1	NS
Passive range of motion (flexion)	118.1 ± 13.3	120.6 ± 17.3	116.7 ± 4.8	123.7 ± 13.3	NS

NS indicates not significant.
*P less than .05 between TKA and OA side in group A using Wilcoxon t test.
†P less than .05 between TKA and OA side in group B using Wilcoxon t test.

Table 3. Knee Kinematics and Kinetics During Level Walking (Mean ± Standard Deviation)

	Group A (n = 20)		Group B (n = 5)		Statistical Significance
	TKA Side	OA Side	TKA Side	OA Side	
Knee flexion angle (°) at heel strike	3.2 ± 1.8	5.6 ± 2.4	7.0 ± 1.5	5.7 ± 3.5	NS
Knee adduction moment (%BW Height)	2.8 ± 2.2	4.0 ± 0.8*	2.4 ± 1.4	3.9 ± 0.5†	
Knee extension moment (%BW Height)	1.5 ± 1.1	1.9 ± 1.2	0.8 ± 0.5‡	0.7 ± 0.6§	

*P less than .05 between TKA and OA side in group A using Wilcoxon t test.
†P less than .05 between TKA and OA side in group B using Wilcoxon t test.
‡P less than .05 between TKA side in group A and TKA side in group B using Mann-Whitney U test.
§P less than .05 between OA side in group A and OA side in group B using Mann-Whitney U test.

concentrated on the importance of knee extension [23,24]. From our results, ability to extend the knee joint during standing was considered to be a key factor to decide loading condition in both limbs. Previous studies have shown that knee extension limitation of greater than 15° in standing would cause balance impairment and lead to mechanical overload to contralateral knee during gait [17,18,25]. In our study, asymmetrical loading in both limbs may result from less extension and quadriceps muscle weakness in the operated knees during relaxed standing. In particular, replaced knees in group B could not extend fully during standing; and knee extension limitation greater than 15° in standing was observed, even if knee flexion contracture was not detected by physical examination. On the other hand, static alignment (ie, knee adduction moment) and subjective pain were not factors to affect the loading condition. These results indicate that, if the operated knee has enough extension in standing, the operated limb becomes dominant. On the contrary, if extension limitation is seen in the operated knee in standing, the limb would not have dominant loading. Because postoperative passive range of motion was not significantly different between the groups, the cause of the extension limitation in standing should not be flexion contracture; and it might be other factors such as quadriceps strength. In fact, significantly smaller extension moments in operated knees were detected in OA-dominant group than in TKA-dominant group (Table 3).

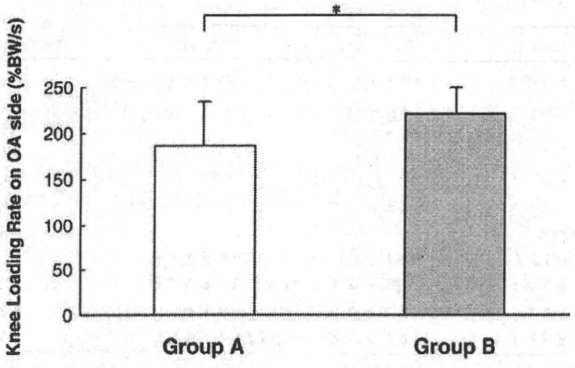

Fig. 3. Maximum knee loading rate (%BW per second) on OA side during level walking in each group (*$P < .05$).

Quadriceps muscle strength is an important consideration in gait characteristics after TKA. Yoshida et al [26] indicated that, when the operated limb had a very weak quadriceps, patients would depend on the nonoperated side to compensate by placing greater forces on the nonoperated leg during gait. Thus, retraining program that encourages the patients to use improvements in quadriceps strength with greater knee extension during standing can be effective.

The patients with medial knee OA have increased knee adduction moment during walking, and a primary strategy of the treatment is to reduce the moment [27]. After unilateral TKA in patients with bilateral knee OA, net knee adduction moments in TKA are significantly smaller than those in nonoperated knees [28]. This fact is related to static alignment (varus deformity) [29]. On the other hand, the adduction moment in patients with medial knee OA can be reduced by walking more slowly [27]. These gait changes basically appear to be associated with *increased loading rates*, defined as increased slopes of the ground reaction force curve immediately after heel strike during walking [30,31]. Although the knee forces reported in the present study were measured indirectly, the axial loading rate was considered to be good estimates of the actual loading rates at the knee. According to previous studies, higher loading rates have been shown to generate more surface fissuring of cartilage than lower loading rates [32]; and surface fissures in the cartilage can propagate mechanically if the joint surface is subjected to rigorous repetitive loading [33]. Mechanical overload in the contralateral osteoarthritic knee can be a factor to progress the disease severity. Therefore, it is important to examine the ability to extend the replaced knee in standing as a postoperative evaluation after unilateral TKA.

Conclusion

After unilateral TKA in patients with bilateral symptomatic OA, TKA knees had dominant weight bearing in 80% of patients, although the other 20% who had extension limitation in standing put more weight on OA side with greater loading rate during walking. Extension limitation in the operated knee in standing may lead to mechanical overload in the contralateral osteoarthritic

knee, which can be a factor to progress the disease severity. Therefore, the ability to extend the replaced knee in standing is important as postoperative function after unilateral TKA.

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高齢者の運動機能障害評価 運動器障害診断ツール(足腰指数25)の開発

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赤居正美[*3]，飛松好子[*3]，岩谷力[*3]

緒言

平成20年9月15日時点で65歳以上の人口は2,819万人，平成25年には3,000万人を超えると推定されている．

高齢者の急増に伴い，平成12年4月に218万人の認定者数で開始された介護保険は，平成20年4月には460万人を超え，費用も3兆円から7兆円に急速に拡大している．介護認定者の増加要因を分析すると，要支援あるいは要介護1の比較的軽症者の増加率が最も高い(**図-1**)．さらに，この軽症者を要支援者に限ると，その原因としては骨折転倒・関節疾患など運動器疾患の比率が32.7%と最も高い(**表-1**)．

自立した快適な老後を過ごすことは万人の望みであり，そのためには健康寿命を損ねている3大疾患，すなわち**表-1**に示す脳血管疾患，運動器疾患，認知症の対策が肝要である．脳血管疾患に関しては，出血や梗塞の背景になる高血圧・糖尿病・高脂血症などを予防する目的で，その上流にある肥満を早期に検出する特定健診が，メタボリックシンドローム(メタボ)というキャッチコピーの元に，政策として平成20年春から導入されている．

一方，介護原因として2番目に頻度の高い運動器疾患の対策は，メタボに比べると明らかに遅れている．平成12年から始まった「健康日本21」の中間評価(**表-2**)では，平成17年時点での国民の身体活動・運動の量は策定時よりも減少しており，事業の中心であった地方推進事業が期待される成果を挙げていないと解釈することができる．

このような認識のもと，運動器障害により要介護となるリスクの高い状態をロコモティブシンドローム(ロコモ)と呼び，運動器障害の重要性に気づかせる啓発活動を日本整形外科学会(以下日整会)(平成19年9月，中村耕三理事長)が開始した[1]．このロコモ啓発キャンペーンは，マスコミなどを用いて積極的に展開されている．

ロコモを早期に発見できれば，適切な運動習慣(スポーツも含む)の導入や運動器リハビリテーションの介入などにより，高齢者が要介護になることを予防できると考えられ，つまり，このような健診体制を確立できれば，個人としての健康寿命延伸に寄与するのみでなく，介護に要する総費用の軽減も期待できるのである．厚生労働科学研究として，平成20年度から「運動器障害の早期発見診断ツール開発研究」を開始したので，その中間的成果を報告する．

ロコモ診断ツールの条件

1. 簡便であること

高齢者全員を，運動器を専門とする整形外科医師専門医(15,000人)が診察することは不可能であ

*1 自治医科大学整形外科
*2 福岡クリニック
*3 国立障害者リハビリテーションセンター

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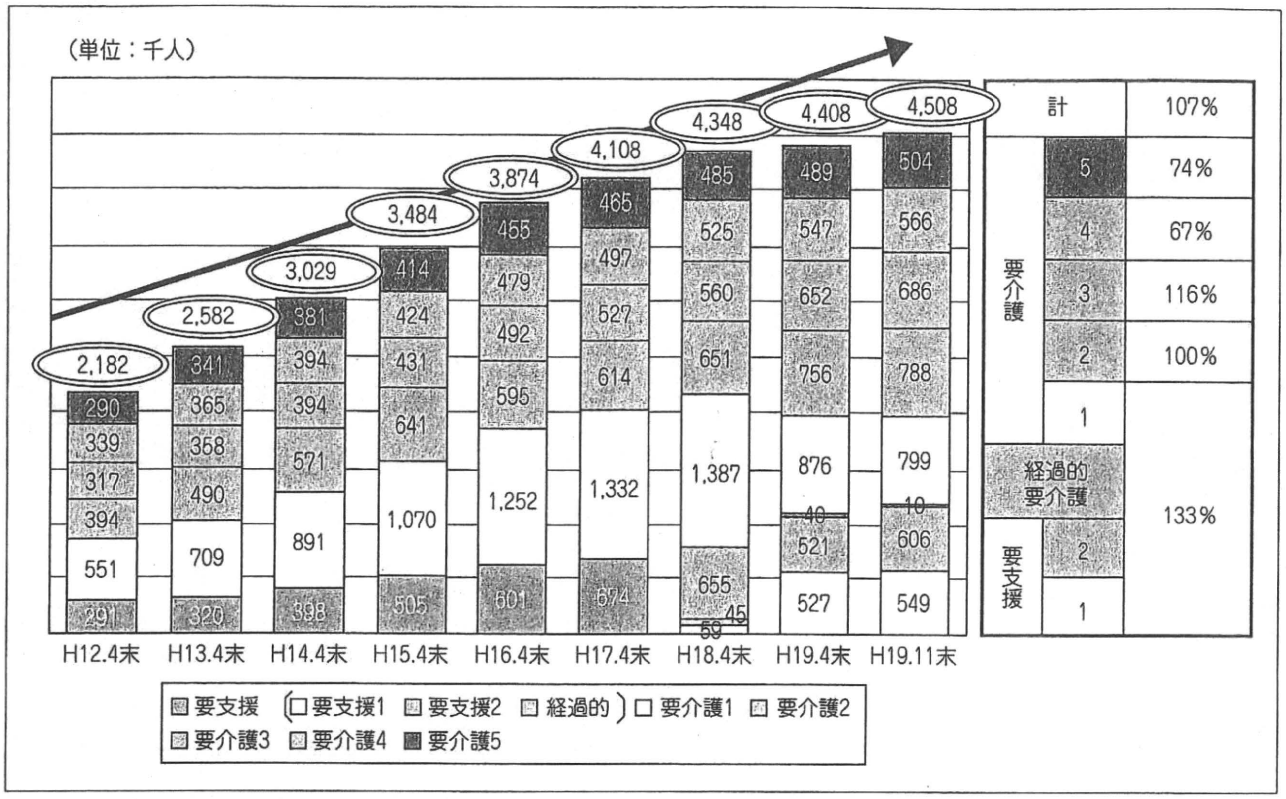

図-1◆介護保険認定者数の推移（出典：介護保険事業状況報告他）
要支援～要介護１の軽症者の増加率が高い．

表-1◆支援・介護が必要となる原因（平成19年度国民生活基礎調査）　（%）

	脳血管疾患	認知症	骨折転倒関節疾患	高齢による衰弱
要支援	14.9	3.2	32.7	16.6
要介護	27.3	18.7	17.5	12.5
総　数	23.3	14.0	21.5	13.6

り，プライマリケア医，あるいは医師以外の行政担当者でも用いることができるように，診断ツールには簡便さが求められる．

2．診断精度が高いこと

整形外科専門医でなくても確実に運動器障害を診断できる精度が求められる．また，診断ツールには障害程度の変動に対する鋭敏な感度も必要で

表-2◆「健康日本21」中間評価（2007年４月10日厚生科学審議会地域保健健康増進栄養部会）
身体活動・運動は策定時に比べむしろ減少している．
地方推進事業の失敗：元気高齢者しか参集しない．

身体活動・運動 目標項目		策定時 平成12年	実績値 平成17年	目標値 平成22年
日常生活における歩数の増加	成人男性	8,202歩	7,532歩	9,200歩
	成人女性	7,282歩	6,446歩	8,300歩
	70歳以上男性	5,436歩	5,386歩	6,700歩
	70歳以上女性	4,604歩	3,917歩	5,900歩
運動習慣者の増加	男性	28.6%	30.9%	39%
	女性	24.6%	25.8%	35%

表-3⇒「足腰25：運動器疾患と日常生活での困難さについての調査」(足腰指数25)

「お体の状態」と「ふだんの生活」について，手足や背骨のことで困難なことがあるかどうかをおたずねします．この１ヵ月の状態を思い出して以下の質問にお答え下さい．それぞれの質問に，もっとも近い回答を１つ選んで，□に✓をつけて下さい．

この１ヵ月の体の痛みなどについてお聞きします．

1．頚・肩・腕・手のどこかに痛み(しびれも含む)がありますか．
□痛くない　□少し痛い　□中程度痛い　□かなり痛い　□ひどく痛い

2．背中・腰・お尻のどこかに痛みがありますか．
□痛くない　□少し痛い　□中程度痛い　□かなり痛い　□ひどく痛い

3．下肢(脚のつけね，太もも，膝，ふくらはぎ，すね，足首，足)のどこかに痛み(しびれも含む)がありますか．
□痛くない　□少し痛い　□中程度痛い　□かなり痛い　□ひどく痛い

4．ふだんの生活でからだを動かすのはどの程度つらいと感じますか．
□つらくない　□少しつらい　□中程度つらい　□かなりつらい　□ひどくつらい

この１ヵ月のふだんの生活についてお聞きします．

5．ベッドや寝床から起きたり，横になったりするのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

6．腰掛けから立ち上がるのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

7．家の中を歩くのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

8．シャツを着たり脱いだりするのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

9．ズボンやパンツを着たり脱いだりするのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

10．トイレで用足しをするのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

11．お風呂で身体を洗うのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

12．階段の昇り降りはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

13．急ぎ足で歩くのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

14．外に出かけるとき，身だしなみを整えるのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

15．休まずにどれくらい歩くことができますか(もっとも近いものを選んで下さい)．
□２－３km以上　□１km程度　□300m程度　□100m程度　□10m程度

16．隣・近所に外出するのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

17．２kg程度の買い物(１リットルの牛乳パック２個程度)をして，持ち帰ることがどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

18．電車やバスを利用して外出するのはどの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

19．家の軽い仕事(食事の準備や後始末，簡単なかたづけなど)は，どの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

20．家のやや重い仕事(掃除機の使用，ふとんの上げ下ろしなど)は，どの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

21．スポーツや踊り(ジョギング，水泳，ゲートボール，ダンスなど)は，どの程度困難ですか．
□困難でない　□少し困難　□中程度困難　□かなり困難　□ひどく困難

22．親しい人や友人とのおつき合いを控えていますか．
□控えていない　□少し控えている　□中程度控えている　□かなり控えている　□全く控えている

23．地域での活動やイベント，行事への参加を控えていますか．
□控えていない　□少し控えている　□中程度控えている　□かなり控えている　□全く控えている

24．家の中で転ぶのではないかと不安ですか．
□不安はない　□少し不安　□中程度不安　□かなり不安　□ひどく不安

25．先行き歩けなくなるのではないかと不安ですか．
□不安はない　□少し不安　□中程度不安　□かなり不安　□ひどく不安

表-4◆医師が判定する運動器障害重症度(ロコモ度)

1. 無症状・障害なしの者
   運動器に関する症状がなく，日常生活にも制限がない者
2. 有症状・歩行移動に支障ない者
   運動器に関する愁訴・症状はあるが，歩行・移動に制限がない者
3. 特定高齢者相当の者
   運動器に関する症状があり，歩行・移動に支障があるが，日常生活は自立しており，要支援・要介護に該当しない者
4. 要支援相当の者(要支援1，2相当)
   日常生活上の基本的ADLはほぼ自分でできるが，手段的ADLにはなんらかの支援を要する者
5. 要介護1相当の者
   手段的ADLを行う能力がさらに低下し，部分的な介護が必要な者
6. 要介護2相当の者
   基本的ADLについても部分的な介護が必要な者

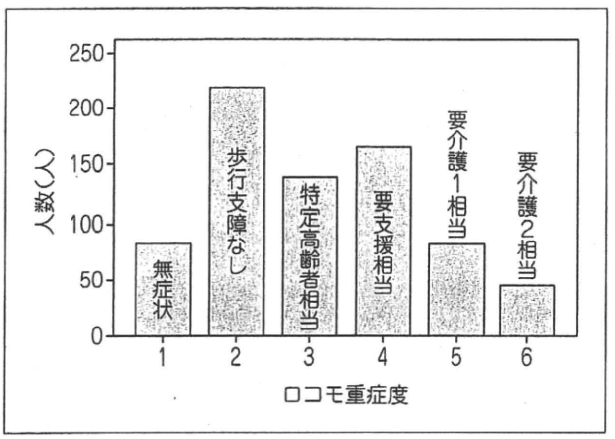

図-2◆調査対象のロコモ重症度
731名(男217名/女514名)　平均77.3歳(65～96歳).

あり，治療介入の効果判定などにも用いることができるような設定が必要とされる.

診断ツール策定の手順

1. 患者質問票の作成

運動器機能に関するものを中心に過去の質問表を調査し，討議を重ねて患者質問票を作成した.自記式が簡便であり，また内容としては運動機能のみでなく，回答者の日常生活動作の困難さ，さらには健康感にも及ぶ内容も導入した．25問の質問を設け，0(障害なし)～4(最重症)点の5段階評価とし，総点は0(障害なし)～100点(最重症)となるように策定した．質問票の名称を足腰指数25と称することとした.

2. 多施設調査の実施

a. 対　象

・65歳以上の高齢者800名を目標数とした.
・整形外科外来受診者，整形外科に併設された通所リハビリテーション施設でリハビリを受けている者，健常対照高齢者.
・自記式質問票に記入できるという条件設定により，認知症患者を対象から除外した.

b. 調査項目

・運動器疾患名
・足腰指数25(**表-3**)
・運動器障害重症度(**表-4**)：介護保険などにおける判定基準を参考に，6段階に運動機能(いわばロコモ度)を区分した．行政による介護度認定には認知機能なども反映されてしまうので，本調査では運動器機能の重症度を，担当した整形外科専門医が示す**表-3**の基準によって判断することとした.

c. 研究の倫理的側面

・対象者には研究の概要・意義を説明し，文書で研究参加の承諾を得た.

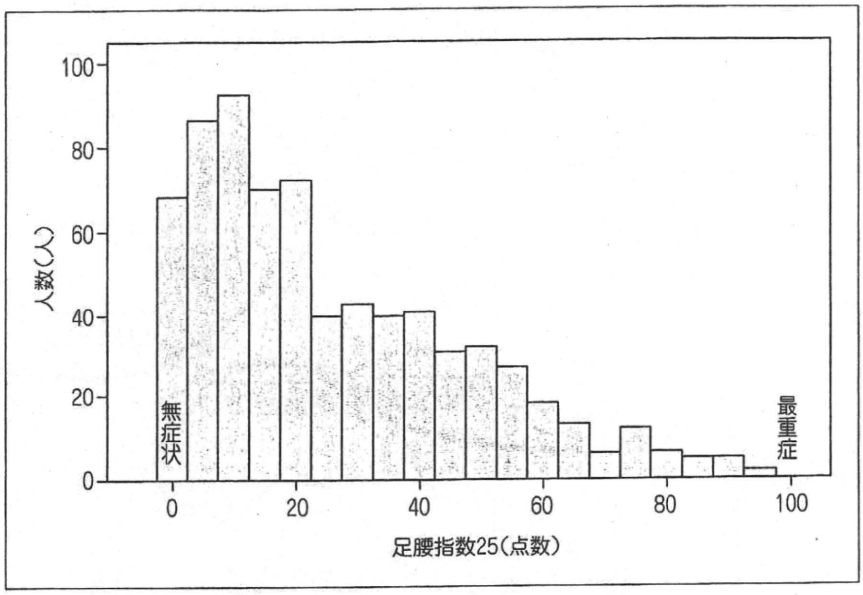

図-3◆対象の足腰指数25点数(n=731)

・プロトコールは日整会の倫理委員会で平成20年10月29日に承認を受けた.

d. 実施期間・場所

・平成20年11月～平成21年２月の４ヵ月間に調査を行った.

・日本臨床整形外科学会会員施設および自治医大関連施設において調査を行った.

3. 足腰指数25・機能検査法の評価

多施設研究による800例のデータから，足腰指数25(質問票)の妥当性などを検討した．赤池の情報量規準(AIC)を用い，質問項目間の関連の度合いを定量化した．これは横断的調査からリスクファクターを抽出できる方法であり，最適なカットオフ値を求めることができる．信頼性分析はクロンバックαに，再現性分析は折半法，基準関連妥当性の検証にはEuro EQ-5D を対照に用いた.

握力，片脚起立時間とロコモ度との関係を検討した.

調査対象の詳細

781名の調査票が集積されたが，データに欠損のあるものを除いた731名を解析対象とした．その内訳は男217名，女514名，年齢は65～96歳，平均77.3歳であった.

整形外科専門医による診断名(複数回答あり)は，変形性膝関節症304名，変形性脊椎症253名，骨粗鬆症208名，腰部脊柱管狭窄症121名，健常者82名などであった.

対象のロコモ重症度は**図-2**のごとくであり，無症状から最重症の要介護２まで，比較的まんべんなく各重症度の対象者が分布していた.

結　果

1. 足腰指数25(質問票)の策定

策定した足腰指数25を**表-3**に示す.

2. 多施設調査結果

足腰指数25の集計結果を**図-3**に示す．半数以上が20点以下の比較的軽症群であることがわかる.

3. 足腰指数25

a. 信頼性，妥当性

足腰指数25の信頼性分析結果としてのクロンバックαは0.961であり，すべての質問間に強い相関があり，不要な質問がないことが判明した．再現性の分析は折半法により，信頼係数0.899と極めて良好であった．基準関連妥当性の検討ではEuro EQ-5D の効用値と高い相関(スピアマン順位相関：$p<0.001$)があった．構成概念妥当性の検証を赤池の情報基準量 AIC[2] を用いて行い，各項目間で関連度の高いものを線で結んで視覚化したものを**図-4**に示す．この結果から，痛み，屋内

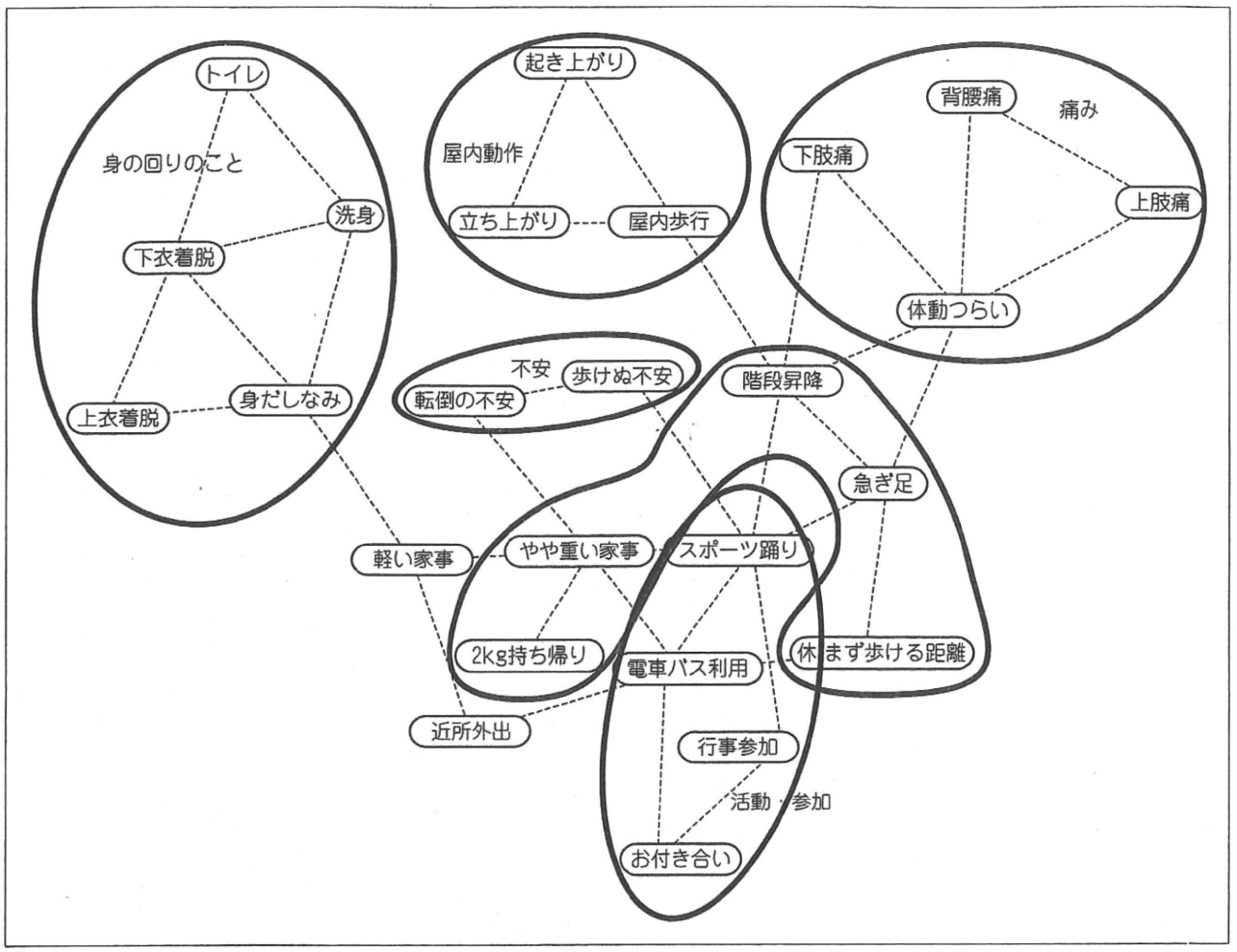

図-4◆AIC による構成概念妥当性の検証結果(visual 化)
５つの項目の重要性.

動作，身の回りのこと，不安，活動・参加と名づけられる５つのドメインが浮かび上がった．また，25項目の中でも中心的な５つの項目が存在することが判明し，**図-4**では馬蹄形(ピンク)で囲んだ．足腰指数25の設問数が多過ぎると考えられる場合には，この５問(いわば「足腰指数５」)を簡略型として用いることもできる可能性がある．

b．カットオフ値の設定

足腰指数25の総得点の多寡から特定高齢者相当をピックアップするカットオフ値を求めることが，ロコモの早期診断ツールとして必要であり，**図-5**に示すように最適モデルはカットオフ値16点の場合，という結論に到達した．つまり，整形外科専門医の判断する特定高齢者相当の者(運動機能障害により歩行移動に障害があるが自立している)を，プライマリケア医あるいは行政担当者でも自記式質問票のみで抽出することができる，ということなのである．ちなみに簡略型の足腰指数５では０(無症状)～20(最重症)点であるが，足腰指数25の場合と同様の操作により求めたカットオフ値は６点であった．今後，この足腰指数５の妥当性もさらに検討する予定である．

考　察

整形外科専門医が「運動機能障害により歩行移動に障害があるが自立している」と判定した者を，「運動器障害により要介護となるリスクの高い者：すなわちロコモ」と仮定した場合，足腰指数25による調査で16点以上を示す者がロコモに該当すると判定できることになる．この足腰指数25を用いることにより，運動器疾患を専門としない