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CASE REPORT

Total knee arthroplasty for rheumatoid knee with bilateral, severe flexion contracture: report of three cases

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Abstract The treatment of patients with severe flexion contracture of the rheumatoid knee, deprived of ambulation for long periods of time, is challenging. Based on three cases, we indicate the potential risks of posterior dislocation of the knee after total knee arthroplasty. In this pathological condition, surgeons must carefully select the type of implant in order to avoid this serious complication. We also emphasize the importance of working on disuse muscle atrophy of trunk (back, abdominal) and lower limbs, both of which play an integral role in ambulation. The personality of each rheumatoid patient should be carefully considered when considering surgical and rehabilitation options.

Keywords Knee joint · Flexion contracture · Rheumatoid arthritis · Total knee arthroplasty

Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory disorder characterized by synovial hyperplasia and resulting joint destruction. Recent advances in the early diagnosis and medical treatment of RA, including the use of biological agents, joint replacement surgery and social care programs, all contribute to improvements in the management as well as the maintenance of daily life activity in rheumatoid patients. Nevertheless, patients who have not received any systematic treatment are still found on rare occasions in Japan. Among those patients, some develop severe flexion contracture in both of their knees, and thus are deprived of ambulation for long periods of time. Many reports on flexion contracture management in the knee are available in the literature [1–4]. However, there are few reports concerning the treatment of severe flexion contracture of 60° or more [1]. Furthermore, the pathology of bilateral flexion contracture of the knee joint is not a single problem related to the affected knee joints. Several other aspects, including disuse muscle atrophy of the trunk (back and abdominal) and the entire lower limbs, should also be considered. In addition, the medical history as well as individual personalities of the patients should be carefully considered, since such patients have previously declined surgical intervention aimed at regaining ambulation. We report three cases of bilateral severe flexion contracture of the rheumatoid knee and indicate (1) the potential risks of total knee arthroplasty in this unusual condition, (2) the importance of recognizing atrophy in the muscles integral for ambulation as well as the individual patient's preferences for treating this condition.

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Case reports

Patient 1

A 48-year-old woman first consulted us in April, 2004, complaining of an inability to stand and walk. She had

been diagnosed with RA in 1988, and had undergone an open synovectomy on her right knee at a local hospital in 1994. The surgery led to no noticeable improvement, and as a result she refused further examination, medication and orthopedic management. Over the following years, flexion contracture of both knees gradually developed, so that she had been unable to stand or walk for three years. She explained her distrust of medical treatment, which we attempted to dispel through careful interviewing and by explaining the treatment.

On examination, she had significant flexion contracture in both knees (Fig. 1a). The range of motion of her right knee was from 85° to 130° (Fig. 1b). The range of motion of her left knee was from 75° to 130° (Fig. 1c). Significant joint stiffness was observed in her right knee, presumably due to intra-articular adhesion caused by the open synovectomy ten years before. Thus, we considered that improvements in contracture by casting or splinting would not be effective. Her left knee, in contrast, was less stiff, suggesting that corrective casting or splinting might improve flexion contracture of the knee.

Both knees indicated total knee arthroplasty. Because of the severity of the flexion contracture of both knees, we opted to attempt to improve contracture before proceeding with total knee arthroplasty. Open surgery (surgical manipulation) was performed on her right knee. Intra-articular scar tissue was heavily adherent to the damaged joint surfaces. Scar tissue and the posterior joint capsule were removed. In order to improve contracture to below 45° as recommended by Laskin et al. [4], the iliotibial tract and biceps tendon were elongated by a Z-plasty procedure. As a result, her right knee reached 35° at full extension. For her left knee, serial corrective casting was applied, carefully avoiding hinged force. Within two weeks, her left knee could be comfortably moved to 34° at full extension.

Since the left knee responded favorably to correction without surgical intervention, we decided to perform TKA (Genesis II, posterior stabilized; Smith & Nephew, Memphis, TN, USA) first on the left knee (Fig. 1d). Massive soft tissue release and an additional distal femur cut were necessary to secure the extension gap. The early postoperative results were satisfactory, and the patient was able to stand up seven days postoperatively, thus promoting muscle exercise in the trunk (back and abdominal) and lower extremeties.

Encouraged by the result in her left knee, TKA was performed on her right knee with the same method and implant (Fig. 1e). Full extension was obtained within ten days. On the 20th day postoperatively, the patient complained of discomfort in her right knee in the absence of any external force while resting in bed with her knee at extension. Immediate examination revealed that the tibia had been dislocated posteriorly (Fig. 1f). Even under general anesthesia, closed reduction was not possible, and an open reduction procedure was selected. Open reduction was successful and confirmed that no parts of the implant had been broken. Following reduction, the knee was protected for four weeks by long leg cast immobilization. After cast removal, quadriceps exercise and careful knee motion exercise were re-introduced. By six months after initial evaluation and treatment, the patient was able to stand up quickly, and to walk stably without using crutches. On examination one year after initial treatment, the range of motion for the problematic right knee was between 10° and 110° with 5° of extension lag. The range of motion for the less problematic left knee was between 5° and 135° without any extension lag. These functions showed no deterioration at the two-year follow-up, and her quality of daily living activities had significantly improved.

Patient 2

A 58-year-old woman had been diagnosed with RA in 1978, and treated in our institution since 1989. By 2004, her left hip showed rapid destruction, causing an inability to walk (Fig. 2a). She refused total hip arthroplasty (THA) on her left hip due to a fear of any kind of surgery. In succession to her hip problems, both knees rapidly developed severe flexion contracture, which made it impossible for her to stand. She endured six months of this condition before finally agreeing to THA.

On examination, the range of motion in her right knee was between 60° and 95° (Fig. 2b). The range of motion in her left knee was between 60° and 75° (Fig. 2c). Soon after the THA (K-MAX system, Japan Medical Materials, Osaka, Japan), external static splinting was selected to improve the flexion contracture of both knees in place of serial corrective casting as used in patient 1. This was due to a feeling that casting might be too heavy and uncomfortable during such an early postoperative period. Both knees responded favorably to splinting during the postoperative rehabilitation period. At four weeks postoperatively, the range of motion in the right knee was between 25° and 80°, while the left knee was between 20° and 75°. Since both knees responded promptly to splinting and the quadriceps muscles were functioning well, we selected a routine implant (Genesis II, posterior stabilized; Smith & Nephew, Memphis, TN, USA) used in the treatment of the majority of rheumatoid knees at our institution. Operations in both knees were performed in a routine fashion without resecting excessive amounts of the distal femur, and without sacrificing the iliotibial tract or biceps tendon (Fig. 2d, e). At three months after the initial THA, the patient was able to stand without any assistance, and walk stably without

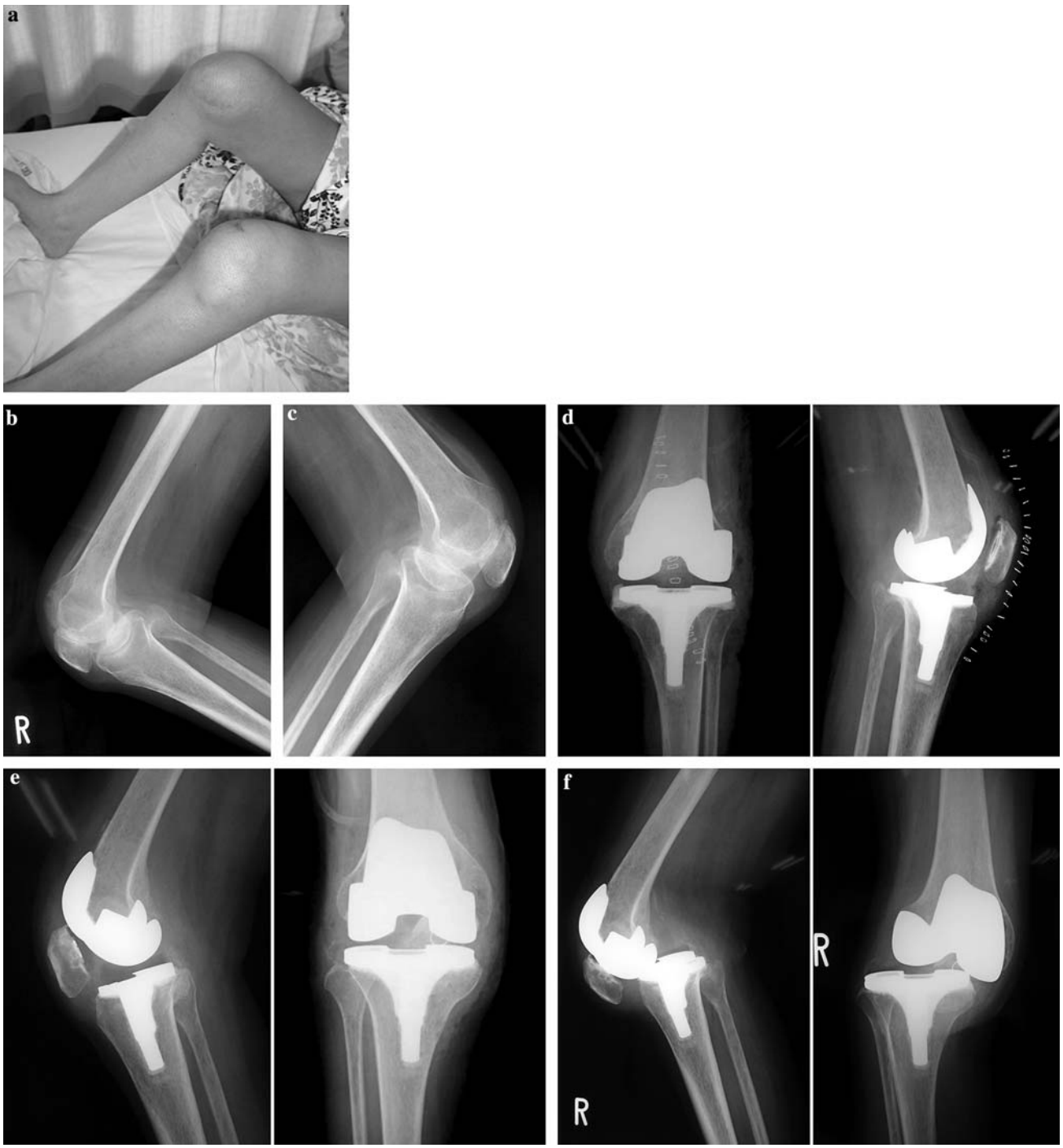

Fig. 1 Patient 1. **a** Preoperative condition of the lower limbs in patient 1. **b** Plain lateral radiograph of the right knee reveals marked patellar baja. **c** Plain lateral radiograph of the left knee. **d** Plain anteroposterior, lateral radiograph of the left knee after TKA. **e** Plain anteroposterior, lateral radiograph of the right knee after TKA. **f** Plain anteroposterior, lateral radiograph of the dislocated, right knee. The right knee was dislocated during bed rest without any application of external force

crutches. At the one-year follow-up, the range of motion of the right knee was between 15° and 110° with 10° of extension lag. The range of motion of her left knee was between 15° and 85° with 5° of extension lag.

Patient 3

A 47-year-old woman was diagnosed with RA at the age of 30, and was treated in our institution for 14 years. She had

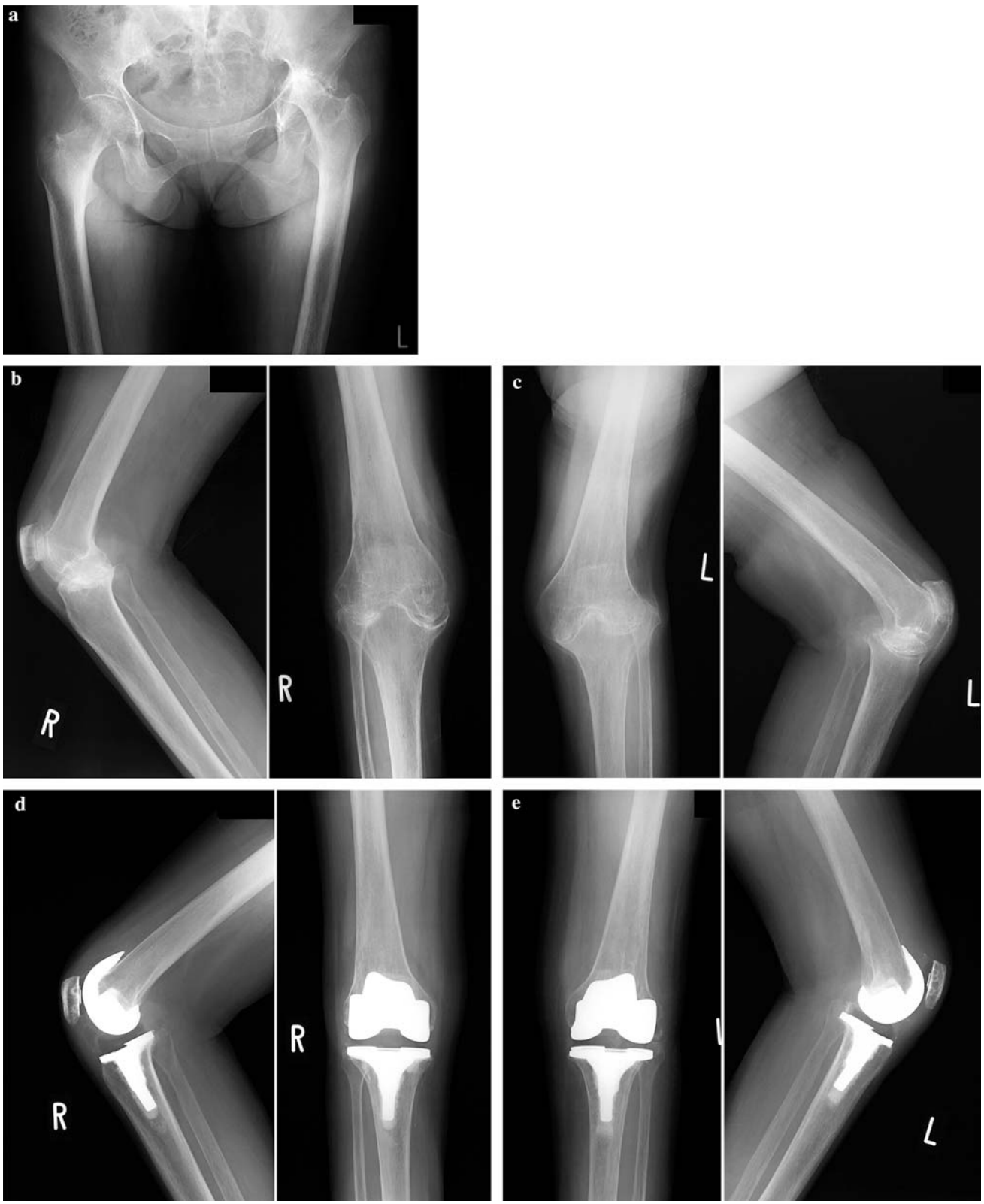

Fig. 2 Patient 2. **a** Plain anteroposterior radiograph reveals destructive left hip joint. **b** Plain anteroposterior, lateral radiograph of the right knee. **c** Plain anteroposterior, lateral radiograph of the left knee. **d** Plain anteroposterior, lateral radiograph of the right knee after TKA. **e** Plain anteroposterior, lateral radiograph of the left knee after TKA

undergone a synovectomy on her right elbow eight years before at our institution. Elbow surgery results were poor, which caused her to distrust joint surgery. Since 1998, pain in her bilateral knees had gradually progressed to flexion contracture. Home exercise aimed at preventing flexion contracture was introduced, but the flexion contracture advanced in both knees, depriving her of ambulation (Fig. 3a). Since the joint surfaces were severely damaged and the flexion contracture was irreversible, we proposed TKA. However, she refused surgery, and as a result was unable to stand or walk for four years. In 2005, she finally agreed to TKA.

Preoperative examination indicated a range of motion in her right knee of between 60° and 120° (Fig. 3b), and that the range of motion in her left knee was between 65° and 125° (Fig. 3c). Both knees were equally impaired. At first, serial corrective casting was introduced to her left knee. Extension of the left knee improved from 65° to 42°. At this point, preoperative surgical planning suggested that a massive release of soft tissue during TKA would be necessary to secure full extension. Thus, in order to avoid postoperative dislocation as had occurred in the right knee of patient 1, we selected an implant with a higher constraint usually used for revision surgery (Genesis II, Revision TKA; Smith & Nephew, Memphis, TN, USA) (Fig. 3d). Knee extension angle improved promptly after surgery to 10°. While continuing postoperative exercises in the left knee, the right knee was treated in the same fashion (40° in extension by preoperative casting, followed by TKA of higher constraint) (Fig. 3e). Owing to the higher stability of the condylar constrained knee, postoperative exercises in both knees could be performed intensively with confidence. The strength of her hip and trunk muscles as well as quadriceps muscles improved rapidly with standing exercises. The patient was able to walk stably without crutches by three months after the initial treatment on her left knee. At the one-year follow-up, the range of motion of her right knee was between 15° and 105° without any extension lag. The range of motion of her left knee was between 15° and 90° without any extension lag. The patient reported significantly improved daily life activities, including an ability to walk outdoors.

Discussion

Recently total management of RA has become widespread in Japan. However, patients may become nonambulatory when progression of flexion contracture occurs in their knees. This pathology may be left untreated due to a patient's preference or fear of surgery, as in the three patients presented above. The resultant severe flexion contracture associated with advanced arthritic changes of the knee is one of the most demanding procedures in knee surgery [1, 4]. Knees with severe flexion contracture usually present with posterior subluxation of the tibia, valgus deformity, and external rotation of the tibia, which can be partially attributed to the contracture and the traction of the biceps muscle and iliotibial tract [2]. Attempts to improve the contracture with splinting, corrective casting, skeletal traction or operative joint mobilization are generally accepted [4]. Laskin et al. [4] reported that decreasing the contracture to below 45° is advisable before performing TKA, and we were able to achieve this in all three patients in our small series. Significantly decreasing severe contracture is beneficial if it is carried out within a short period of time in the absence of complications. The method that should be applied is largely dependent on the severity of the contracture as well as the length of time the patient has experienced contracture. Our observation that splinting was sufficient in reducing the contracture to below 25° in patient 2 suggests that a shorter duration of severe contracture (six months in patient 2) requires a less invasive method of correction. In contrast, in the previously operated right knee of patient 1, operative joint mobilization was required since the scar tissue that firmly adhered to the articular surface obstructed any improvements in motion by the external force generated by corrective casting or splinting.

After decreasing the contracture to below 45°, TKA is performed in a sequential manner. Posterior release is mandatory to obtain the highest degree of extension possible [1–4]. Since the degree of viscoelasticity of the soft tissue varies among patients [5], surgical planning such as additional distal femur cut or proximal tibia cut should be individualized as a result of physical examination and the length of time that the flexion contracture has been present. In many cases of TKA for treatment of a severe flexion contractured knee, an ideal soft tissue balance is difficult to obtain during surgery [4, 5]. In both the right and left knees in patients 1 and 3, mediolateral balance and equal extension and flexion gaps were impossible to obtain despite careful preoperative surgical planning and meticulous soft tissue release during surgery. When a soft-tissue imbalance is present, surgeons have to carefully select the type of TKA. The component selection for TKA, the expected results and the potential risks are widely debated [6–8]. We believe that a cruciate-retaining knee should be considered only in the presence of a well-balanced knee, and that a posterior-stabilized knee might have more predictable results for rheumatoid knee over both the short and long term [6]. However, a posterior-stabilized knee cannot compensate for severe laxity or imbalance [7, 9]. In unusual conditions such as in the patients presented here, we believe a more constrained device might produce a safer postoperative condition, and

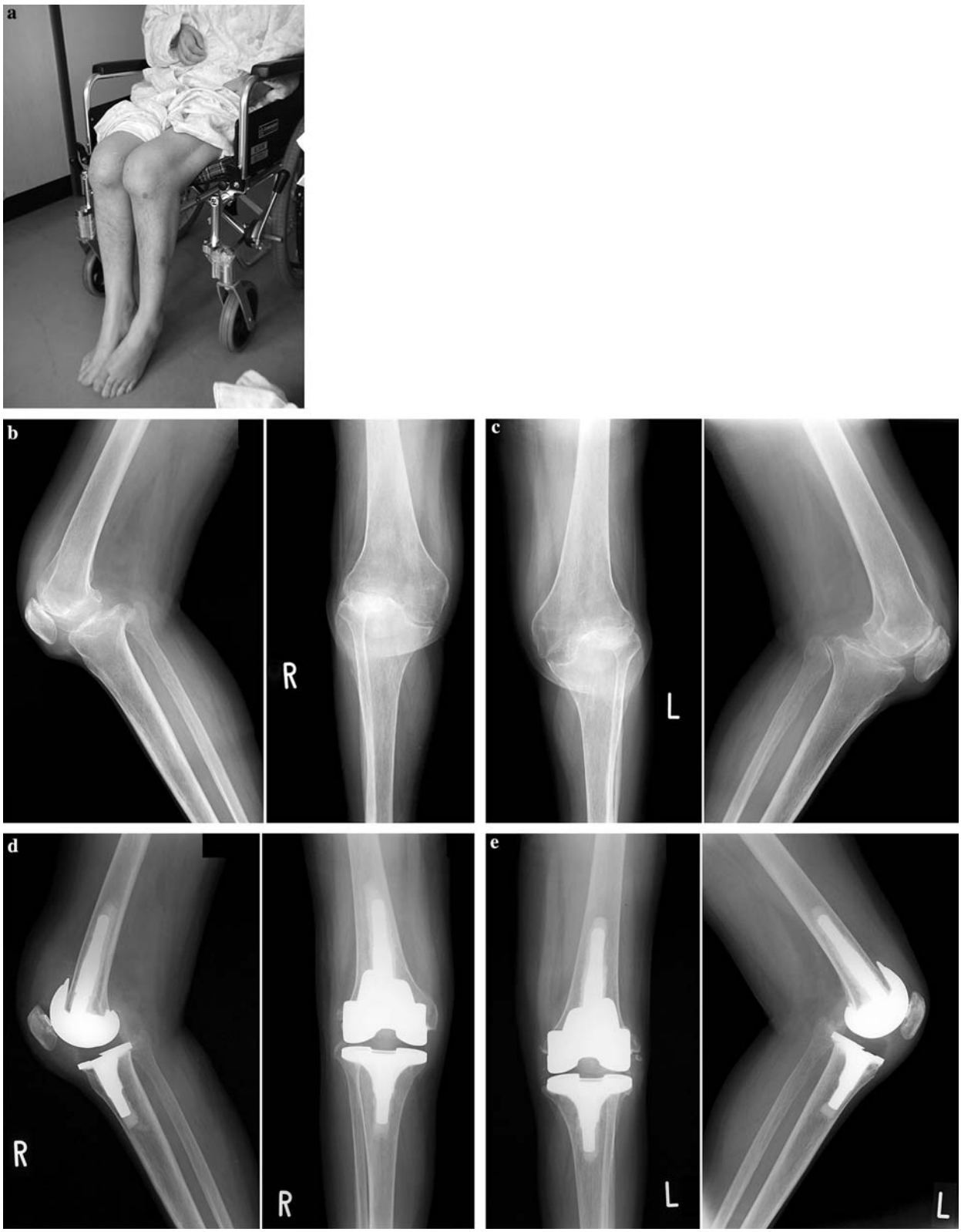

Fig. 3 Patient 3. **a** Preoperative condition of patient. The patient had been unable to leave the wheelchair by herself. **b** Plain anteroposterior, lateral radiograph of the right knee. **c** Plain anteroposterior, lateral radiograph of the left knee. **d** Plain anteroposterior, lateral radiograph of the right knee after TKA of higher constraint. **e** Plain anteroposterior, lateral radiograph of the left knee after TKA of higher constraint

thus more desirable results. It is true that more constraint has the disadvantages of transferring shear and rotational stress to the bone–cement interface, which can adversely affect implant longevity [9, 10]. However, as in patients 1 and 3, if functional loss of collateral ligaments and significant loss of mediolateral balance are observed during surgery, and the early postoperative incompetence of the extensor mechanism for stabilizing the tibia against posterior translation are noted (this incompetence presumably caused the posterior dislocation of right knee of patient 1), the more constrained device might provide reliable stability. Another possibility for the knees in patient 1 and 3 is a rotating hinge device [10, 11], which has a more constrained mechanism than the condylar constrained device. However, after observing how the dislocated knee in patient 1 gradually obtained both static and dynamic stability, it was speculated that a large degree of constraint might only be required in the early postoperative period. Gradual recovery of the extensor mechanism and soft tissue healing may function as a stabilizer at some point after surgery. Furthermore, considering the relatively young ages of patients 1 and 3, excessive constraint of the implant should be avoided. These considerations led to the selection of a condylar constrained device in patient 3 [9, 10].

The mechanism as well as the potential risks of posterior dislocation of TKA should be carefully considered. Generally, it is believed that the knee position for posterior dislocation is deep flexion and rotation. However, Lombardi et al. [12] showed that the knee position in slight flexion is most vulnerable to posterior dislocation for a posterior-stabilized knee using a cadaveric experiment. The right knee in patient 1, for which a fair extension angle was achieved within a short period, was dislocated at this position. We emphasize the risks of posterior dislocation in the early postoperative period after TKA in the severe flexion-contractured knee, when the knee has obtained a good extension angle but the extensor mechanism is not yet sufficiently functioning. Splinting may be useful for avoiding accidental, unfavorable external force. However, knees are vulnerable during this period, so careful attention should even be paid when knees are splinted.

All three patients could stand and walk in a forward bending posture during the early postoperative phase of postoperative rehabilitation, either all the time or when exhausted by exercise. Roentogenograms of their spines showed no vertebral wedging. These observations suggest the weakness of the lumbar extensor muscles compared to the lumbar flexor muscles [13], due to disuse atrophy during the nonambulatory period. Although related to each other, standing and walking are dependent not only on functional knee joints, but also on stable trunk muscles used as lumbar extensors. In our patients, isometric exercise of lumbar extensors was introduced daily, and were effective at improving gait posture.

When interviewing patients who have previously declined appropriate medical treatment, the treatment methods should be carefully explained. In our three patients, distrust and anxiety were the underlying causes of the untreated flexion contracture of the knee. The behavior of nonambulatory patients is likely to be more complex than generally implied by the "RA personality" [14, 15]. Surgeons should be aware that it may take a long time to achieve surgical agreement, and thus a routine schedule for TKA is of little use.

In conclusion, TKA can be performed successfully in the unusual condition of bilateral, severe flexion contracture of the rheumatoid knee. In an early postoperative period, the potential risk for posterior dislocation may be high, which justifies the use of a more constrained implant in carefully selected cases. It is important to recognize and to work on disuse atrophy of both lower limbs and trunk muscles, as well as to understand the personality of each patient as a prerequisite for successful surgery.

Conflict of interest We declare that there are no financial or other relationships that could lead to a conflict of interest.

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