up results for cemented alumina ceramic TEA with an SKC-I prosthesis for reconstruction of RA elbows.

High-density polyethylene articulating against a metallic femoral head or distal femoral mold has been the commonly used bearing couple in total joint replacement, but the biological response to polyethylene particulate debris from bearing surfaces is regarded as one cause of periprosthetic osteolysis and aseptic loosening of the prosthesis [20]. Alumina ceramics are not soluble and do not break down in the body; they are also relatively inert biologically and are therefore biocompatible materials without risk of ion release. Biomechanical characteristics of low friction are suitable for artificial joint surfaces when combined with an HDP surface. This is the first study to describe the long-term clinical results and longevity of an unlinked alumina ceramic TEA. The results reveal long-term outcomes are satisfactory for the SKC-I prosthesis without ceramic failure. However, an ulnar component fracture at the screw hole connection between the HDP and ceramic stem was seen for one elbow (elbow no. 11). To solve this problem, a new model of implant after the SKC-I, developed and introduced in 1999, used an all-polyethylene ulnar component.

There are several literature reports analyzing the survival of TEAs with long-term follow-up extending beyond 10–15 years. Among unlinked implants, survival was 90 % at 16 years for Kudo type-3 prosthesis [7], 87 % at 12 years [5] and 77.4 % at 10 years [21] for the Souter–Strathclyde prosthesis with revision or implant removal as the end point, and 89 % at 81 months for the Kudo type-5 prosthesis with loosening as the end point [22]. Among linked implants, survival was 88–94 % for the GSBIII prosthesis [10, 23], and 92.4 % for the Coonrad–Morrey prosthesis at a minimum of 10 years [24]. The results of our study are indicative of favorable survival of the SKC-I prosthesis over 10 years, and are comparable with those for established implants. In this study, survival for "loosening" as end point was higher than for "revision" as end point. This might be partly because radiographic loosening determined in this study did not always lead to implant displacement or clinical impairment.

The complication that distinguishes an unlinked prosthesis from linked devices is the incidence of dislocation [25]. The rate of dislocation of an unlinked TEA varies from 3 to 15 % in the literature [5, 26–28]. The Kudo elbow prosthesis is an established elbow prosthesis that has relatively strong intrinsic stability and reproduces the soft tissue tension by use of a spacer effect. A common practice during implantation of the Kudo prosthesis involves sacrificing the MCL during surgery for better access to the joint and easier exposure of the bones for proper setting of the prosthesis, and to facilitate treatment of flexion contractures. Therefore, the joint line tends to shift further distally, and improvement of extension is often not expected. Tanaka et al. [29] stressed the importance of correct orientation of the components and restoration of length, without preservation of the anterior oblique component of the MCL, for preventing dislocation.

Unlike the Kudo or Souter–Strathclyde prostheses, intrinsic stability of the SKC-I prosthesis is minimal, and the SKC-I prosthesis largely depends on the soft tissue for stability. Preservation of the MCL makes intra-operative soft tissue balancing easier, resulting in prevention of internal and/or external rotational malposition of the ulnar component relative to the trochlea, and minimizes maltracking of the joint. Thus, pre-operative inflammatory tears or intra-operative injury to the MCL or bony destruction of the humeral and ulnar insertions of the MCL are risk factors for post-operative dislocation and/or sub-dislocation when SKC-I prostheses are used. A report by Weiland et al. [30] described their experience of 20 % malarticulation and 5 % dislocation with capitellocondylar TEAs. In a comparative study, Little et al. [31] reported dislocation in 1 of 33 Souter–Strathclyde prostheses and 2 of 33 Kudo implants. In our series, there were 6 cases of dislocation or subdislocation (11.1 %). We believe the initial learning curve involved in becoming familiar with the surgical technique needed for this new prosthesis in the 1980s, and the early challenge of the relatively broad indication of this unlinked prosthesis with relatively weak intrinsic constraints to Larsen grade V elbows resulted in relatively high dislocation and/or subdislocation. Caution should be exercised when deciding whether or not the elbow has sufficient bone stock, capsular and ligamentous integrity, and muscle strength at the elbow joint to justify use of an unlinked prosthesis for reconstruction of a rheumatoid elbow [32].

In our earlier experience, TEAs using SKC-I prostheses without cement fixation failed because of loosening of the humeral component [11], which showed early proximal subsidence and simultaneously tilted with the proximal end of the humeral stem displaced anteriorly and the ceramic trochlea posteriorly. Because the solid ceramic trochlea does not resist the forces at the joint, the intramedullary stem is the only structure that stabilizes the humeral component, as occurs with the Souter–Strathclyde prosthesis. In contrast, the Kudo prosthesis, with a saddle-shaped humeral surface, provides reliable uncemented fixation for the humeral component because it holds the cortical bone of the trochlea. As a result, occurrence of loosening with the Kudo prosthesis is high around the ulnar component rather than the humeral component [33]. Potter et al. [22] also pointed out that the valgus tilt of the ulnar component might be related to loosening of the Kudo prosthesis. Interestingly, for elbows fitted with an SKC-I prosthesis with or without cement fixation, most loosening occurs around the humeral component rather than the ulnar component; this might be partly explained by the different

intrinsic stability of the Kudo and the SKC-I prostheses. The results of our study, showing that the incidence of aseptic loosening is lower among patients with >5 years of follow-up than among those with <5 years of follow-up, might be indicative of improvement of the cementing technique during the initial learning process; however, post-operative fractures increased with time. Olecranon fractures occurred as a result of direct trauma for 4 elbows in 3 patients, and for two elbows in patients with severe osteolysis around the humeral component. Osteolysis related to accumulation of polyethylene wear particles seems to be a concern in the long term.

This study had some limitations. First, one surgeon performed all the surgery, and as one of the designers of the prosthesis was well-informed of its advantages and disadvantages. As previously pointed out by Potter et al. [22], results from the center where a prosthesis was designed are usually good, and evidence from other centers to confirm the reproducibility of clinical outcomes are needed. Second, the last observation carried forward method used in this study might cause bias in interpreting the results by over-reporting beneficial outcomes or under-reporting the incidence of late complications of the surgery; however, in our local district most information about severe complications in TEAs that require treatment would be reported to our center. The deaths of 27 patients (39 elbows) were revealed during this review, which is a fate of this type of long-term follow-up study.

In conclusion, we demonstrated quite favorable long-term results with the SKC-I prosthesis, an anatomically-designed alumina ceramic elbow prosthesis for reconstruction of damaged rheumatoid elbows with reasonable pain relief and improved ROM. Survival was comparable with that reported for other implants. Loosening related to osteolysis over the long term remains a problem. The risk of dislocation can be minimized by using proper indications for this implant and careful surgical technique.

Conflict of interest The authors declare that they have no conflict of interest. In the Department of Orthopaedic Surgery (Head of department, Professor Toshifumi Ozaki), Okayama University, there is a small department named "Department of Medical Materials for Musculoskeletal Reconstruction" donated by the KYOCERA Medical Corporation.

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CASE REPORT

Involvement of valgus hindfoot deformity in hallux valgus deformity in rheumatoid arthritis

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Abstract The involvement of valgus hindfoot deformity in hallux valgus deformity was confirmed in a rheumatoid arthritis case with a destructive valgus hindfoot deformity. Correction of severe valgus, calcaneal lateral offset, and pronated foot deformity instantly normalized hallux valgus deformities postoperatively. Thus, careful hindfoot status evaluation is important when assessing forefoot deformity, including hallux valgus, in rheumatoid arthritis cases.

Keywords Rheumatoid arthritis · Hallux valgus · Hindfoot deformity · Lateral offset · Valgus hindfoot

Introduction

Rheumatoid arthritis (RA) is a systematic autoimmune disorder that involves all organ systems. The inflammatory process within the joint synovium leads to joint erosion, ligament laxity, and subsequent deformity. The rheumatoid foot is commonly affected at an early stage, with a prevalence of up to 90 % for involvement of the forefoot. The joints of the midfoot are involved in 40–60 % of RA patients, and the ankle and subtalar joints are involved in 30–60 % [1]. It has been reported that valgus hindfoot causes abnormal and excess forefoot pressure on the medial side [2]. Furthermore, it has also been reported that an increased frequency of flatfoot is correlated with first ray deformity (chiefly metatarsus primus varus) [3]. These observations strongly suggest that involvement of valgus hindfoot deformity plays a key role in the progression of forefoot deformity, including hallux valgus. Indeed, it is described that any individual with flat foot and hallux valgus is at risk of more rapid progression because of the forces that encourage further deformity [4]. However, there is no actual case report that describes the instant improvement achieved after hindfoot corrective surgery.

A case of rheumatoid hindfoot with severe destructive valgus and pronated deformities that was surgically corrected, leading to instant normalization of forefoot deformities (including hallux valgus), is now described.

Patient and methods

A case of rheumatoid forefoot deformity combined with painful hindfoot deformity or destruction underwent surgery, and the details are presented below. The patient fulfilled the 1987 criteria of the American College of Rheumatology (ACR) for RA [5].

Case

A 64-year-old woman with a 15-year history of RA (functional class I, radiographic stage IV) had been treated

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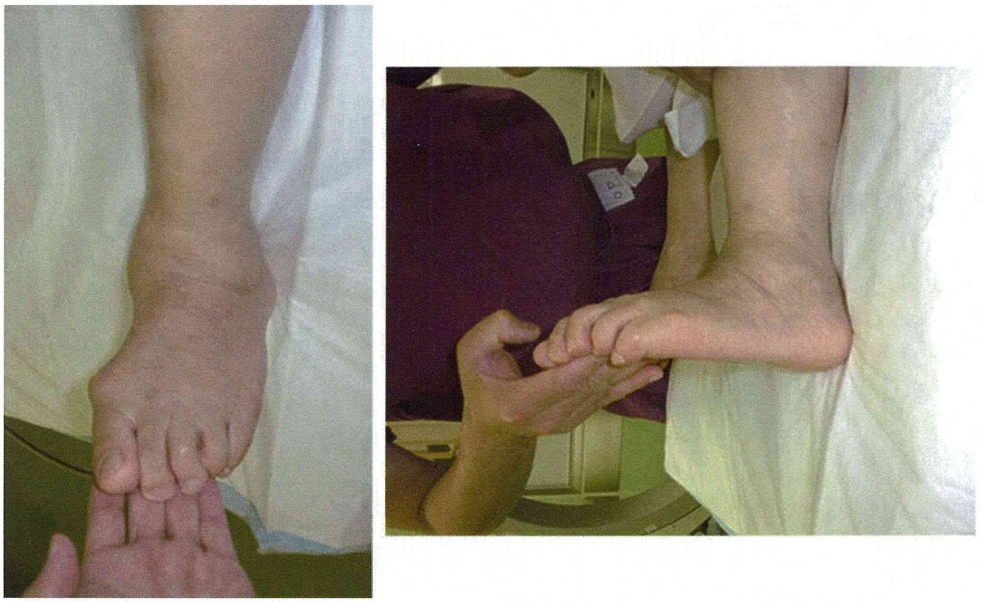

Fig. 1 Preoperative photographs of the affected foot. Images show hallux valgus, claw toe, valgus hind foot, and flatness of lateral longitudinal arch

with 3 mg/kg of infliximab for 3 years, 12.5 mg methotrexate (MTX) per week, and 1 mg prednisolone per day. The patient complained of severe pain in the valgus hindfoot, including the subtalar and talonavicular joints (Fig. 1). Hallux valgus (HV) deformity (HV angle was 34°) was also seen on the radiograph, but there was no pain in the forefoot. Preoperatively, the radiograph showed 11° valgus of the tibiocalcaneal (TC) angle (Fig. 2c), a 30 mm lateral offset between the axis of the tibia and calcaneus (Fig. 2c), and a 161° internal arch (IA) angle (Fig. 2b). The preoperative angle between the short axis of the navicular bone and the long axis of the talus bone (pronated foot index) [6] was 40° (Fig. 2d). Arthrodesis of the subtalar and talonavicular joints was performed with as much correction as possible. After 3 months of non-weight-bearing, the patient was allowed to walk with gradually increased weight-bearing. Finally, the pain in the subtalar and talonavicular joints disappeared. Eight degrees of valgus TC angle remained, but the lateral offset was improved from 30 to 15 mm, and the IA angle was also improved to 149° (Fig. 2b, c). The pronated foot index was improved from 40° to 75° (Fig. 2d). Interestingly, the postoperative (4 months after surgery) radiograph in the standing position showed an instant improvement in the forefoot deformity, including hallux valgus. The preoperative findings HV angle 34°, intermetatarsal 1 and 2 (M12) angle 17°, intermetatarsal 1 and 5 (M15) angle 30° improved to 13°, 10°, and 23°, respectively (Fig. 2d).

Discussion

It has been reported that patients with valgus hindfoot deformities tend to have high medial forefoot pressures, while those with a normal hindfoot recorded normal pressures on the dynamic pedobarograph. The importance of valgus hindfoot should be emphasized, as deformities of greater than 10° were strongly associated with abnormally high medial forefoot pressures and poor results of forefoot surgery [2]. In another words, the greater the valgus hindfoot deformity, the more that surgical intervention to the hindfoot can improve abnormal forefoot pressures. In the present case, clear improvements of lateral offset and valgus hindfoot deformities were achieved (Figs. 2a–c, 3), so there should be normalization of mechanical transmission from the tibia to the forefoot through the hindfoot, talonavicular joint, and midfoot, because improvements of the longitudinal internal arch and of the angle in the transverse plane between the talusnavicular axis (pronated foot index) were achieved. Taken together, forefoot pressure was thought to be normalized. In RA feet, it has been previously reported that multiple joint ligamentous laxity is also present [7], so if

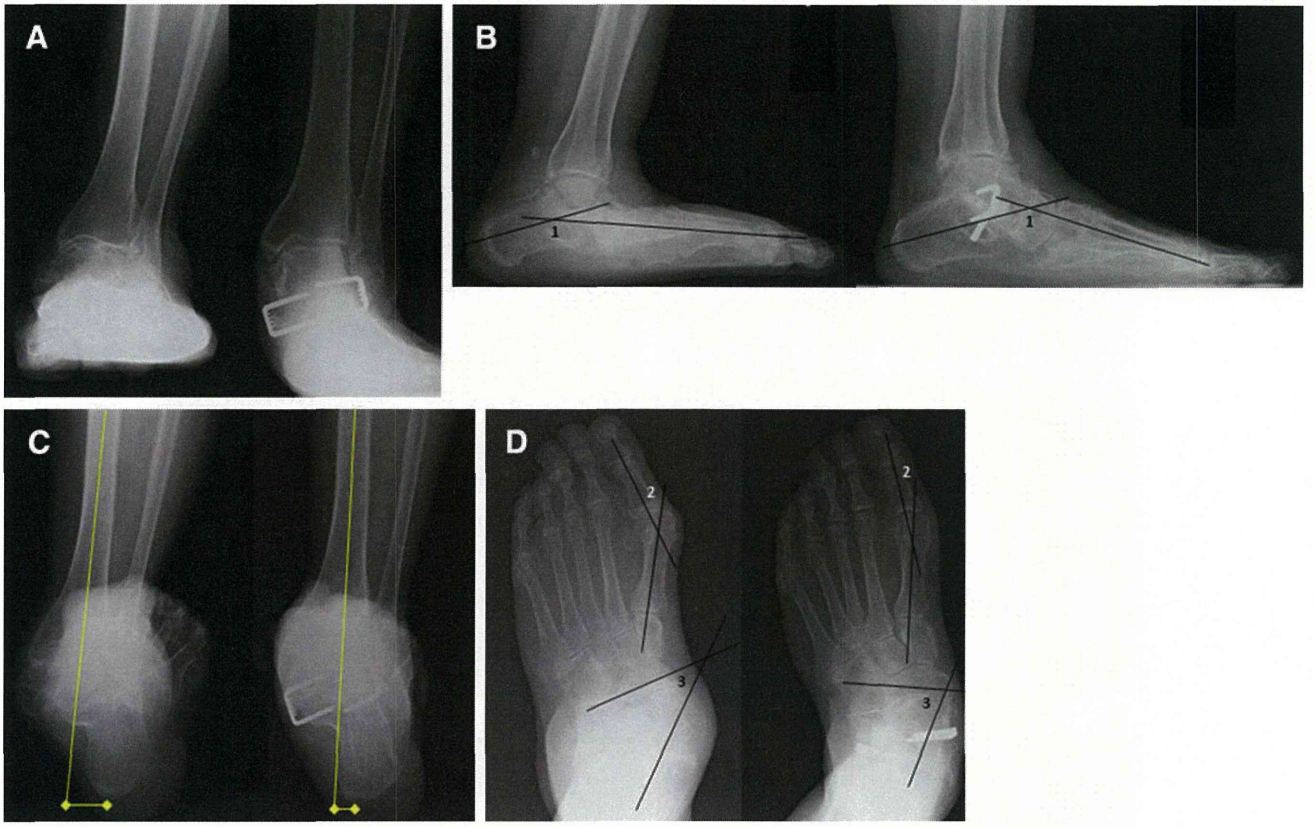

Fig. 2 In all of the X-ray images presented here, the *left panel* shows the preoperative status and the *right panel* shows the postoperative (4 months after surgery) status. A 64-year-old woman with severe pain of the valgus hindfoot including the subtalar and talonavicular joints underwent subtalar and talonavicular joint arthrodesis to achieve as much correction as possible. **a** Anteroposterior (AP) view of the ankle joint in the standing position. **b** Lateral view of the ankle joint in the standing position. The IA angle improved from 161° to 149°. *Angle1*: IA angle. **c** Subtalar joint radiography performed using the modified Cobey method. The TC angle changed from 11° valgus to 8° valgus. The distance between the axis of the tibia and the tip of the calcaneus was defined as the calcaneal lateral offset (*between yellow dots*). **d** AP view of the foot in the standing position. The pronated foot index improved from 40° to 75°. The HV angle of 34°, M12 angle of 17°, and M15 angle of 30° improved to 13°, 10°, and 23° after surgery. *Angle 2*: HV angle. *Angle 3*: pronated foot index

forefoot deformities can be corrected manually preoperatively, it is plausible to consider that correction of severe hindfoot deformity contributes to an instant correction of forefoot status, including hallux valgus. In fact, the present case was corrected manually in the forefoot part, and showed an instant reduction in HV deformity. Of course, the change in hindfoot alignment may produce a photogenic effect in forefoot rotation. While this effect may be another reason that the HV angle seems to decrease, the compatibility of the first MTP joint was restored and the position of sesamoid was also improved (from grade VI to grade IV) [8]. We therefore believe that mechanical transduction through the hindfoot to the forefoot was also ameliorated.

In the present case, the IA angle was incompletely corrected postoperatively (149°). Thus, there is concern that HV could remain or progress, because flatfoot is said to be related to first-ray deformity [3], but correction of the calcaneal lateral offset and pronated foot deformity provided clear normalization of the HV in our case, suggesting that calcaneal lateral offset deformity and pronated foot deformity play a more important role in the progression of hallux valgus than loss of the longitudinal internal arch. Further follow-up and confirmation are required in the future.

In addition, a new question arises. In a case with painful hallux valgus deformities combined with severe valgus hindfoot deformities without pain, which part should be treated first? This is an issue to be resolved in the future.

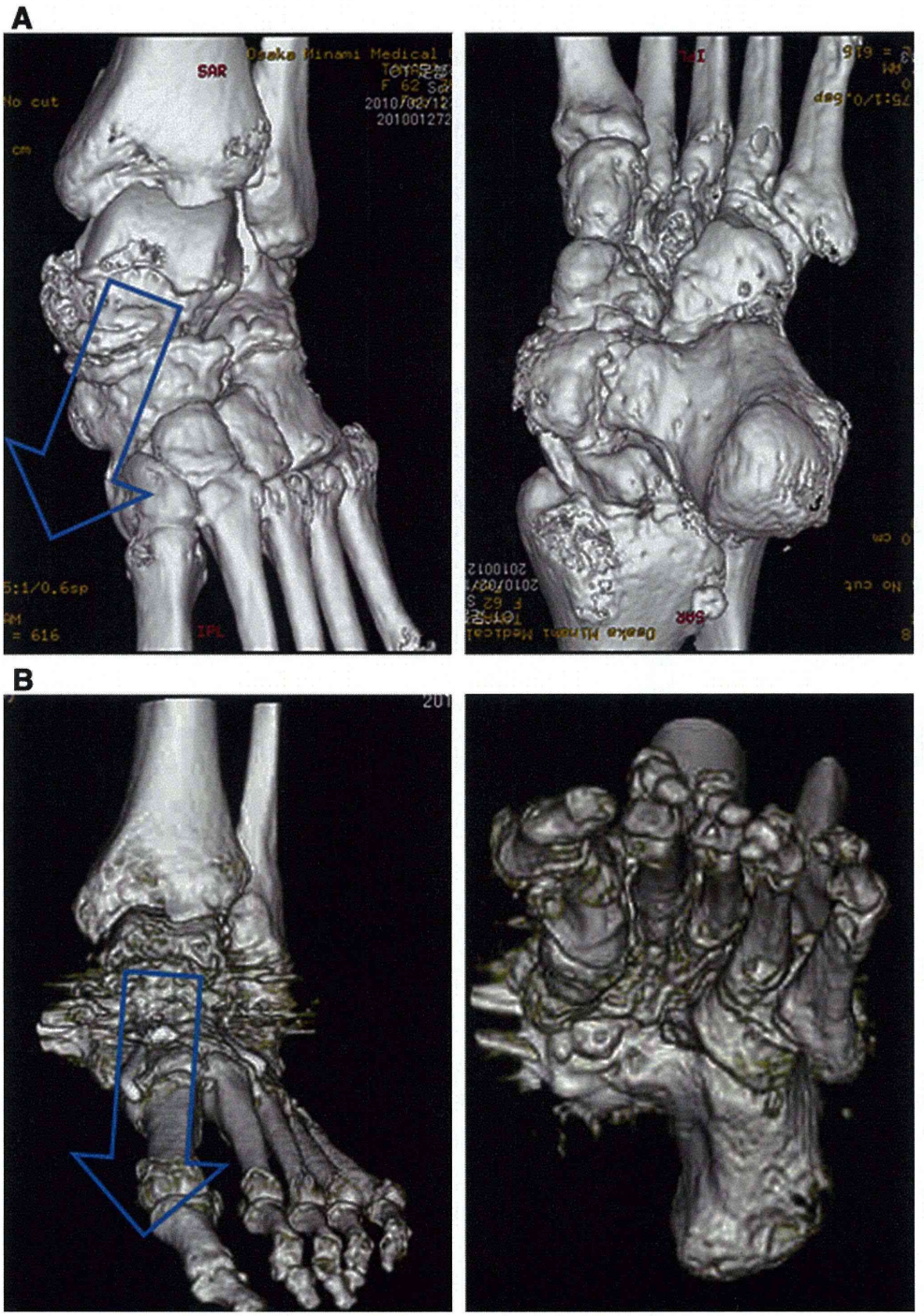

Fig. 3 Preoperative (**a**) and postoperative (**b**) images from three-dimensional computed tomography (3DCT). Preoperatively, dislocation of the talus bone from the talonavicular joint was confirmed, suggesting a severely pronated foot (*blue arrow* in **a**), while reduction of the talus bone was seen postoperatively (*blue arrow* in **b**). Severe calcaneal lateral offset deformity was also confirmed preoperatively (**a** *right panel*), while this was medialized (**b** *right panel*) postoperatively

Conclusion

A case showing that correction of severe valgus hindfoot deformity contributes to instant normalization of forefoot deformity, including hallux valgus, was described. The present result strongly reconfirms that careful assessment of hindfoot status is important when evaluating forefoot deformity, including hallux valgus, in rheumatoid arthritis cases.

Conflict of interest None.

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ORIGINAL ARTICLE

Analysis of perioperative clinical features and complications after orthopaedic surgery in rheumatoid arthritis patients treated with tocilizumab in a real-world setting: results from the multicentre TOcilizumab in Perioperative Period (TOPP) study

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Abstract
Objective To evaluate perioperative changes in rheumatoid arthritis (RA) patients treated with tocilizumab.
Methods We collected RA cases with tocilizumab and orthopaedic surgery from 1999 to 2010. Incidences of postoperative infections, delayed wound healing, and RA symptom flare-ups were extracted from the data for comparison with patients without these postoperative events. We also evaluated the changes in C-reactive protein (CRP) and body temperature in patients without postoperative complications with normal CRP before surgery, i.e., patients without postoperative events in whom the tocilizumab level was maintained, for each duration to discontinuation before surgery.
Results A total of 161 cases ($n = 122$) were collected. The patients had mean age of 56.9 years, and mean disease duration of 12.8 years at operation. Joint replacement

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surgery was performed in 89 cases. Three patients had postoperative infections (two superficial and one organ/space surgical-site infection), 20 had delayed wound healing, and 36 had RA symptom flare-ups. Delayed wound healing occurred most commonly in patients who underwent spinal surgery ($P = 0.0061$, versus patients without delayed wound healing). CRP levels were high when tocilizumab was restarted in patients with RA symptom flare-ups ($P = 0.0010$, versus patients without RA symptom flare-ups). Increased postoperative CRP was observed in patients without postoperative events when the duration from final tocilizumab infusion to surgery was long. The changes in body temperature showed a similar trend to CRP.

Conclusions Although it has been demonstrated that infection rates in patients treated with tocilizumab are by no means high, incidence of delayed wound healing was significantly higher in cases with surgical interventions such as foot and spinal surgeries. Many patients treated with tocilizumab remained in a normal range of CRP even during the perioperative period. For prevention of perioperative complications, observation of postoperative conditions and surgical wounds, and subjective symptoms of patients are considered important.

Keywords Orthopaedic surgery · Rheumatoid arthritis · Surgical-site infection (SSI) · Tocilizumab · Wound healing

Introduction

Rheumatoid arthritis (RA) is a common inflammatory joint disease. Its course varies greatly from a mild disease to a severe, destructive variant that rapidly progresses over a few years.

In recent years, analgesic and anti-inflammatory drugs, including steroids, have been used to suppress symptoms, while disease-modifying antirheumatic drugs (DMARDs) have been used to inhibit or halt the underlying immune process and prevent long-term damage. In particular, biological DMARDs have increased the treatment options, and clinical remission is considered to be the primary goal of RA treatment according to new recommendations from a working group of the American College of Rheumatology/European League Against Rheumatism (ACR/EULAR) that has provided benchmarks toward reaching that target [1].

However, despite aggressive treatment even with biological DMARDs, progressive destruction of joints continues to occur in a subgroup of RA patients who eventually require orthopaedic procedures, including joint replacement surgeries [2, 3]. Therefore, it is speculated that the rate of operations for RA patients treated with biological DMARDs is increasing [4]. However, complications after surgery, especially postoperative surgical-site infections (SSIs), can pose serious functional and psychological challenges to successful RA treatment. The RA patient population as a whole has a higher baseline risk of infectious diseases compared with the general population [5, 6], which in turn may result in the higher infection rate after surgery observed in RA patients compared with the general population [7].

It remains unclear whether use of biological DMARDs, including tocilizumab, constitutes an independent risk factor for postoperative SSIs. Some reports of joint surgeries in RA patients treated with tumour necrosis factor-alpha (TNF-α) blockers have demonstrated no increase in the incidence of postoperative infections [8–10]. In the evaluation of data from the British Society for Rheumatology Biologics Register, Galloway et al. [11] also concluded that the rate of postoperative joint infection was not significantly influenced by anti-TNF therapy. In contrast, other reports have suggested higher complication rates with TNF blockers [12, 13]. Moreover, Suzuki et al. [14] reported that the chance of having biological treatment with joint arthroplasty was more than twofold greater in patients with SSIs compared with those treated with non-biologic agents. These conflicting data make the effects of TNF blocker therapy on the risk of postoperative infection during orthopaedic interventions unclear.

Meanwhile, the perioperative mechanisms of tocilizumab are also currently under investigation. Among the biological DMARDs, tocilizumab is a humanized anti-human interleukin (IL)-6 receptor monoclonal antibody that has been demonstrated to improve RA symptoms [15–19]. Unfortunately, very few studies about the clinical features of tocilizumab-treated RA patients following joint surgery have been reported [20, 21].

Therefore, more data are required to fully evaluate the influence of tocilizumab on postoperative complications. In this study, we analysed the perioperative clinical features and risk ratios for complications such as SSIs and delayed wound healing after surgical interventions in RA patients treated with tocilizumab.

Patients and methods

To evaluate the perioperative changes and complications in surgical interventions for RA patients, the multicentre TOcilizumab in Perioperative Period (TOPP) study was organized to analyse the perioperative features and complications of surgical operations under tocilizumab therapy in 25 hospitals in Japan.

All cases fulfilled the 1987 revised ACR criteria [22] and/or 2010 Rheumatoid Arthritis Classification Criteria