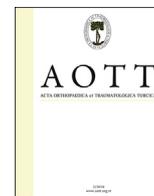


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Short-term results of the management of severe bone defects in primary TKA with cement and K-wires

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ABSTRACT

Objective: The aim of this study was to evaluate the results of cement and kirschner wire augmentation in the management of bone defects in primary TKA.**Methods:** Twenty-four patients (10 male, 14 female; mean age: 66 years) with uncontained unilateral medial tibial articular bone defect who underwent TKA between 2010 and 2014 were included in this study. The average follow up time was 33.7 months. Patients were divided to two groups according to the size of the bone defect (Group 1: <20 mm, Group 2: >20 mm). The tibial defect was reconstructed by using cement and K-wires. We used posterior stabilized prosthesis with no tibial stem extension.**Results:** The preoperative and postoperative lower extremity mechanical axis in Group I was in a mean varus of 15° and mean varus of 3°, respectively ($p < 0.001$). The preoperative and postoperative lower extremity mechanical axis in Group 2 was in a mean varus of 20° and mean varus of 3° respectively in Group II ($p < 0.001$). None of the patients neither suffered from failure of K-wires nor loosening.**Conclusion:** The use of cement and K-wires augmentation appears to be a simple and cost-effective treatment option for the tibial bone defects in primary TKA.**Level of evidence:** Level IV, Therapeutic study.© 2017 Turkish Association of Orthopaedics and Traumatology. Publishing services by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

The goal of total knee arthroplasty (TKA) is to obtain a stable, painless knee with proper limb alignment and joint line.¹ Bone defects in TKA are a significant challenge to the surgeons with regard to maintaining proper alignment of the implant and extremity for establishing a stable bone-implant interface. Instability of the trial implants are indications of management of bone defects in primary TKA at the time of trial reduction. This situation generally occurs when 40% or more of the bone-implant interface is not supported by the host bone. Treatment alternatives for bone defects in TKA -depending on the location, configuration (contained or non-contained) and magnitude- are bone cement, bone cement with screw reinforcement, metal augmentation, impacted bone grafts, structural allografts and tantalum.^{1–9}

The bone cement with screw reinforcement technique was first used by Freeman et al⁹ in 1982 and was first described in the

literature by Ritter⁸ in 1986. The usually accepted indication for this technique is the presence of small contained bone defects.¹ The use of this technique in large uncontained bone defects is not recommended¹; however, Berend et al¹⁰ had reported successful results at long-term follow-up periods (up to 20 years) when screw and cement were used to correct large uncontained tibial defects (5–20 mm). Nevertheless, the literature remains controversial.^{11–13} The operative technique was first described by Ritter where 6.5 mm diameter and 35-mm long two stainless steel AO cancellous bone screws were inserted parallel to the tibial cortex.⁸ We have modified the original description of the operative method by using smooth Kirschner wires (K-wire) instead of screw, for the reinforcement of the cement and management of the medial tibial defect to reveal that the original technique could be performed with K-wires, in order to decrease the cost and to facilitate the surgical procedure.

The aim of our study was to evaluate the results of uncontained medial bone defect reconstruction with cement and K-wire for primary TKA, especially in extra-large medial defects (>20 mm).

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Patients and methods

Seventy-one patients who had undergone primary TKA between the year 2010 and 2014 and had varus deformity and uncontained medial tibial defect were evaluated in this retrospective cohort study. Twenty-four patients' defects, reconstructed using cement and K-wires and had instability of trial components after trial reduction during evaluations of varus-valgus stress test or flexion-extension of the knee joint, were included in this study. These patients were operated by the same surgeon at the same center and a single type of prosthesis was used on them (Sigma; DePuy Synthes, Inc., Warsaw, IN, USA). We used posterior stabilized prosthesis without any tibial stem extension in for all patients. The minimum follow-up period was two years.

Patient data were retrieved from their medical files, operative reports and regular follow-up records. Demographic information such as age, sex, height, weight, body mass index (BMI), side of the operated knee and primary diagnosis were recorded (Table 1). Medial tibial defect classification was made according to the classification system described by Insall.¹⁴ According to this classification system, uncontained defect has segmental bone loss with no remaining cortex. Lotke et al have defined the size of the uncontained defect as 'large' (<20 mm) (Group 1) or 'extra-large' (>20 mm) (Group 2).¹⁵ In our study, the patients were divided into two groups. Patients with a defect <20 mm comprised Group 1 and those with a defect >20 mm comprised Group 2. We administered spinal or combined spino-epidural anesthesia in all patients. A proximal pneumatic tourniquet was inflated to a pressure of 150 mm-Hg above systolic blood pressure and maintained throughout the procedure. Midline longitudinal skin incision and medial parapatellar arthrotomy was performed. Soft tissue releases were carried out to obtain balance of the deformities. The extra-medullary tibial cut was applied to the tibia and the tibia was cut at 8–10 mm from the lateral plateau surface. After the tibial cut, the defect size was measured in width and depth and was recorded in millimeters. The defect was prepared as described by Ritter.⁸ According to this, the defect at the resected tibial plateau were debrided of the surface granulation tissue, exposing the irregular sclerotic and cancellous bone, and the reaming sclerotic bone was drilled to enhance cement fixation. After thorough lavage, pulsed normal saline was used and the prepared surface was left to dry out. Then, 3-mm K-wires were passed almost perpendicular to the defect area, while paying attention to avoid crossing the central and peripheral peg holes on the prepared tibial surface and contacting

the tibial component. One pack of bone cement mix (Biomet, Inc., Warsaw, IN, USA) was applied to both the tibial plateau and tibial component, including the component peg and femoral component. Thus, the defect was repaired and the tibial and femoral components were placed. A final check for soft tissue tension, alignment, patellar tracking and range of knee motion were carried out before closing the wound. The time elapsed from the beginning of the incision to the end of the surgery (skin to skin) was recorded as 'surgery duration' (Figs. 1, 2).

Low-molecular-weight heparin (enoxaparin sodium 0.4 ml, Clexane; Sanofi Aventis, Istanbul, Turkey) was used for thromboembolism prophylaxis. Prophylaxis was discontinued 12 h before surgery and restarted 6 h after surgery and continued up to 3 weeks postoperatively. Antibiotic prophylaxis was administered to all patients (one gram intravenous first-generation cephalosporin (cefazolin sodium, Sefazol; Mustafa Nevzat, Istanbul, Turkey)). Range of motion exercises and weight-bearing walking with a walker was started on the first postoperative day. Patients were discharged once straight leg raising and 90° of knee flexion was achieved. The patients were given follow-up appointments for their postoperative 15th day, 1st month, 3rd month, 6th month, 1st year and after that once a year. During the follow-up period, the patients were invited for clinical and radiographic evaluation by an independent observer (orthopedics assistant).

The Knee Society Clinical Rating System (KSCRS) was used for functional assessment.¹⁶ An orthoroentgenography of the lower extremity of the operated site, standing anteroposterior and lateral views were taken and The Knee Society Total knee roentgenographic evaluation and scoring system were used for all evaluations.¹⁷ Based on these radiographies, the measured radiolucent periprosthetic lines and focal osteolysis were concluded to be evidence of component subsidence. Radiolucent lines (RLL) at the implant-bone interface were measured in millimeters. Focal osteolysis was defined as any progressive osteolytic lesion at the bone-implant or cement-bone interface.¹⁸ Loss of fixation was defined as a continuous RLL >1 mm in all zones or a change in implant position.¹⁹ Complications were also noted.

Statistical analyses with Student's t and chi-square tests were performed using the SPSS 18.0 software (SPSS Inc., Chicago, IL, USA). A p value <0.05 was considered statistically significant.

Results

This study included 24 patients; 10 males (41%), 14 females (59%), with a mean age of 66 (range: 54–83) years. Group 1 consisted of 12 patients; 8 females (66%) and 4 males (34%) with a mean age of 62 (range: 54–75) years and Group 2 consisted of 12 patients; 6 females (50%) and 6 males (50%) with a mean age of 70 (range: 58–83) years.

The etiologies were osteoarthritis in 22 patients (92%), rheumatoid arthritis in one patient (4%), and traumatic arthritis in one patient (4%). The operated knee was the right knee in 18 patients (75%) and the left knee in 6 (25%). There was no statistically significant difference between the groups in terms of BMI ($p > 0.05$) (Table 1).

After the tibial cut, the mean mediolateral width and depth of the medial tibial defects were 26.0 (range: 10–40) mm and 22 (range: 10–40) mm respectively. In Group 1 and Group 2, the widths of the defects were 14 (range: 10–20) mm and 38 (range: 21–40) mm and the depths of the defects were 12 (range: 10–21) mm and 32 (range: 21–40) mm, respectively. The mean follow-up period was 33.7 (range: 24–55) months (mean of 34.8 [range: 26–55] months for Group 1 and 32.6 [range: 24–52] months for Group 2) ($p > 0.05$). The mean duration of surgery was recorded as 100 (range: 80–120) minutes.

Table 1
Demographic data.

	Group 1	Group 2	p
Number	12	12	>0.05
Gender			
Female	8	6	>0.05
Male	4	6	>0.05
Side			
Right	10	8	>0.05
Left	2	4	>0.05
BMI	29.9	30.3	>0.05
Etiology	12 OA	10 OA, 1 RA, 1 TA	>0.05
Defect size (mm)			
Width	14	38	<0.05
Depth	12	32	<0.05
Surgery duration (min)	95	105	>0.05
Follow-up period	34.8	32.6	>0.05

Defect size is statistically different between two groups, defect size is greater in Group 2.

BMI: body mass index, OA: osteoarthritis, RA: rheumatoid arthritis, TA: traumatic arthritis.

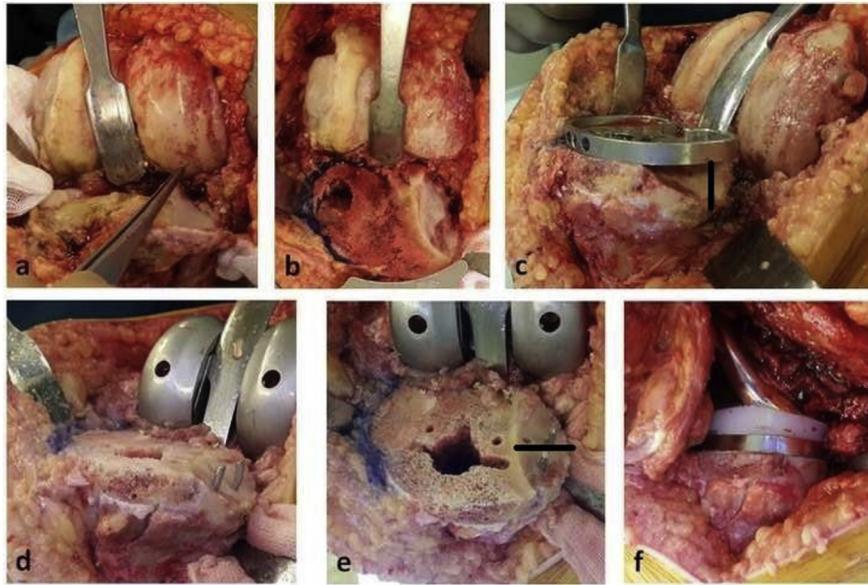


Fig. 1. Intraoperative photos.



Fig. 2. Anteroposterior and lateral views of the knee before and after implantation.

According to the KSCRS, the mean preoperative clinical and functional Knee Society Score (KSS) was 65 (range: 55–72) and 58 (range: 52–68), respectively, while they were noted as 95 (range: 88–100) and 89 (range: 57–100) at the final follow-up ($p < 0.01$). In Group 1, the mean clinical and functional KSS were 68 (range: 58–72) and 60 (range: 55–68) preoperatively and 97 (range: 90–100) and 93 (range: 68–100) postoperatively. In Group 2, the mean clinical and functional KSS were 62 (range: 55–70) and 56 (range: 52–68) before the surgery and 93 (range: 88–98) and 85 (range: 57–90) after the surgery (Table 2). There was a significant difference between the preoperative and postoperative clinical and

functional knee scores of the groups ($p < 0.05$). No radiographic failure was observed on the tibia or the femur at the final follow-up examinations of both groups.

The preoperative and postoperative lower extremity mechanical axis was in a mean varus of 15° (range: 10°–33°) and 3° (range: 0°–5°) respectively in Group 1 ($p < 0.001$), while the preoperative and postoperative lower extremity mechanical axis was in a mean varus of 20° (range: 17°–36°) and 3° (range: 1°–6°) respectively in Group 2 ($p < 0.001$). Analysis of change from the baseline between both groups showed no significant difference ($p > 0.05$). The mean tibial angle (β) and the mean tibial slope (δ) for both groups are summarized in Table 3. RLL of 1 mm was observed in two knees

Table 2
Preoperative and final follow-up KSS clinical and functional scores in Group 1 and 2.

		KSS			KSS		
		Clinical score			Functional score		
		Pre-op	Follow-up	p	Pre-op	Follow-up	p
Group 1	12	68	97	<0.05	60	93	<0.05
Group 2	12	62	93	<0.05	56	85	<0.05

Postoperative clinical and functional KSS scores are better than preoperative scores for both groups and $p < 0.05$.

Table 3
Preoperative and final follow-up roentgenographic evaluation in Group 1 and 2.

	Group 1	Group 2	p
Mechanical axis			
Pre-op	15° varus	20° varus	<0.05
Follow-up	3° varus	3° varus	>0.05
Tibial angle (β)	90.5°	89°	>0.05
Tibial slope (δ)	5°	5°	>0.05

Preoperative median varus angle was greater in Group 2 and $p < 0.05$.

(16%) at the tibial component in Group 2. None of the cases encountered progression of the RLL. No evidence of subsidence of the tibial component and osteolysis around the K-wire was observed. None of the patients suffered periprosthetic joint infection.

Discussion

Depending on the location and size of the defects, several options have been described for the management of uncontained peripheral defects, including: bone cement, bone cement with screw reinforcement, metal augmentation, impaction of bone grafts, structural allografts and tantalum.^{16,20} The treatment of medial tibial defects in varus knee with the cement and K-wire technique had good clinical and radiological results in primary TKA. Additionally, the most important finding in the present study was that this technique proved to be effective in ameliorating extra-large (>20 mm) uncontained medial tibial defects in a two-year follow-up period. The technique is simple, has a short learning curve and is cost-effective. Instead of repairing the defects by using the abovementioned techniques, tibial cut could be performed a few millimeters more to decrease the size of defect, but that would lead to incompatibility of femoral and tibial components. In this situation, the stress on the tibial polyethylene and tibial component-bone interface would increase.^{21–23}

Two types of proximal tibial defects have been described in the literature.^{16,20} A contained defect has an intact cortical rim whereas an uncontained defects has segmental bone loss with no remaining cortex, and offers no support to the tibial tray.²⁰ Cement with screw application is recommended for small uncontained bone defects¹ as it is reliable, reproducible, easily performed, and inexpensive.²⁴ Ritter concluded that in 57 patients that had tibial defects of 9 ± 5 mm and were followed up for a minimum of three years, 25% had non-progressive radiolucency at the bone-cement interface, but none of the components had failed.⁸ In another study of Ritter,²⁴ no progression of RLLs in either the bone-cement or the cement-prosthesis interface after seven years was observed upon implementation of this technique. In Chung et al.'s study²⁵ of 23 TKAs with tibial bone defects fixed with cement and screws and followed up for a mean of 28 months, the mean knee rating and functional score improved significantly, and no RLLs were detected between the prosthesis and cement around the threads of the screws within the bone. Only eight patients had non-progressive RLLs in the bone-cement interface. This technique is recommended for tibial defects of 5–10 mm deep in the literature.² Application of this technique in large uncontained tibial bone defects is not recommended.¹ The large defects, as defined by Dorr,²⁶ may occupy 25% or more of the component undersurface and involve a deficit deeper than 5 mm. Lotke et al stated that any distance greater than 10 mm was considered a significant defect and if the defect is deeper than 20 mm but involving less than of either plateau, the defect can be treated with cement filling.¹⁵ Berend et al has described defective large tibial bone as >5 mm of depth and tibial plateau deformity <50%.¹⁰ In our study, we described the defects larger than 20 mm as 'extra-large' defect and differed from other studies based on the utilization of cement and screw reinforcement in cases of extra-large (>20 mm) uncontained medial tibial defects, and we modified the original description of the operative method by using K-wires instead of screw for reinforcement. Literature data about screw-cement reinforcement technique for extra-large medial tibia defects is limited.^{10–15} Lotke et al¹⁵ reported that 26 of their 59 patients had defects >20 mm and their mean follow-up period was 7.1 (range: 5–11) years. The authors also confirmed only two failures; one due to infection six months after surgery and the other due to steroid-dependent

rheumatoid arthritis. Berend et al¹⁰ reported the results in the use of screws and cement in primary TKA with up to 20 years follow-up. In 79 knees with 'large defects' of 20–30 mm, only one had failure and the failure was due to a fall on the extended knee. In our study, only two cases showed radiolucency of 1 mm and no patients showed any clinical sign. Ritter failed to establish a definitive correlation between the appearance of non-progressive radiolucency and predisposition of the patients to future failure by the radiolucency, as long as the prosthesis was properly implanted and the knee was properly aligned.²⁴ Although medial tibial defect reconstruction with screw and cement had already been elucidated in the literature, reconstruction with cement and K-wires have not been explained yet. Windsor et al stated that wire pins can be used for cement reinforcement but they did not report any clinical evidence regarding this opinion.²⁷ We have modified the original technique by using K-wires instead of screws for cement reinforcement and using this technique for large medial tibial defects. Screws were inserted parallel to the tibial cortex in the technique Ritter explained. However, in our technique, K-wires were placed almost perpendicular to the defect area, paying attention to avoid crossing the central and peripheral peg holes on the prepared tibial surface. We think that studies that biomechanically compare the screw and K-wires reinforcements will contribute to the literature. From the financial point, the K-wires become considerably more enticing. Berend et al stated that, costing roughly 100–137 dollars per screw, this method is an extremely affordable alternative to other more commonly exercised and more costly modalities like wedges, which cost roughly 910–2240 dollars each.¹⁰ By using K-wires and cement, a surgeon will reduce the overall cost without compromising patient survival. Additionally, the implementation of K-wires and cement is relatively easier to perform and requires fewer cuts to the tibial bone, if any, compared to using wedges and other more intensive techniques. In the original cement screw reinforcement technique defined by Ritter and Berend, tibial extension stems were not used for large defects. In our study, we did not use tibial extension stem in order not to increase the cost; we believe that applying the K-wire with cement will be enough for component survival.

Our study had major limitations. First, it was a retrospective study and the sample size was small. Second, we did not compare the results with other bone reconstruction methods, such as bone cement, bone cement with screw reinforcement, metal augmentation, impacted bone grafts, structural allografts and tantalum. In addition, the follow-up period was short (minimum: 24, average: 33.7 months) to evaluate our technique and compare it to other studies. However, all patients underwent surgery with a single implant type and same technique was applied, which may be an advantage. Yet, a large, random, prospective controlled trial is recommended to validate the superiority of one method over the other.

In conclusion, our study showed that the cement reinforcement with K-wire technique could be considered a suitable option in the management of extra-large medial tibial defects in varus knee. The technique allows the use of simple and cheap procedures and provides good stability of the stemless tibial component at the end of two years.

Conflicts of interest

Authors declare that they have no conflict of interests.

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