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True efficiency of arthrodesis in the treatment of periprosthetic knee infection

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Introduction The rate of complications after arthrodesis of the infected knee joint is 84 %, while the incidence of ankylosis failure varies from 17 % to 80 % thereby. At the same time, purulent process recurs in 50 % of cases, and, moreover, 73 % of patients report permanent pain after arthrodesis. **Purpose of the study** To evaluate long-term results of arthrodesis of the knee joint in patients with periprosthetic infection. **Materials and methods** Treatment results in 63 patients with periprosthetic infection of the knee joint who underwent arthrodesis using the Ilizarov apparatus in the period from 2005 to 2015 were assessed. The mean follow-up period was 8 ± 2.72 years (range, 3 to 13 years). There were 21 males (33 %) and 42 females (67 %). Mean age of patients was 59.05 ± 9.64 years (range, 29 to 80 years). **Results** Re-infection occurred in 17 (27 %) out of 63 patients with arthrodesis procedures of the knee joint with the use of the Ilizarov apparatus. It was established that the results of arthrodesis of the knee depend on the bone defect size. **Conclusions** Arthrodesis of the knee joint with the use of the Ilizarov apparatus in patients with periprosthetic infection enables to eradicate infection in 73 % of cases. Consolidation of fragments of the knee joint from the first attempt of arthrodesis was observed in 73 % of patients.
Keywords: arthroplasty, knee, periprosthetic infection, treatment, arthrodesis, Ilizarov apparatus

INTRODUCTION

Arthrodesis of the knee joint has been used by surgeons for more than 100 years and is currently a treatment option after failed arthroplasty, bone tumor, consequences of severe injuries, as well as chronic periprosthetic infection [1, 2, 3]. Orthopedic surgeons are forced to apply arthrodesis of the joint in cases of recurrent periprosthetic infection and failed re-revisions aimed at preserving the implant [4, 5]. The rate of various complications after arthrodesis of an infected joint reaches 84 %, while the incidence of failed ankylosis varies from 17 to 80 %. The latter depends on comorbidities, activity of the purulent process, and the type of osteosynthesis used (plate, intramedullary nail, external fixation device) [6]. At the same time, the purulent process recurs in 50 % of cases and 73 % of patients report persistent pain after arthrodesis [7].

The six-year survival rate of locked intramedullary nails used for knee joint ankylosis in foreign clinics is 74.3 % [8]. Repeated recurrences of infection and failed attempts to produce ankylosis the knee joint frequently result in amputation of the femur [9].

Purpose Evaluate the mid-term results of knee arthrodesis in patients with periprosthetic infection.

MATERIAL AND METHODS

The treatment results of 63 patients with periprosthetic infection of the knee joint which underwent the procedure of arthrodesis using the Ilizarov apparatus from 2005 to 2015 were analyzed. There were 21 (33 %) males and 42 (67 %) females. The average age of patients was 59.05 ± 9.64 years (age range, 29 to 80 years).

According to D.T. Tsukayama's classification, there were 25 (39.5 %) patients with acute postoperative infection, 18 (28.5 %) patients had late chronic and 14 (22 %) acute hematogenous infection. Positive intraoperative culture was detected in six (10 %) cases. At admission to our clinic, manifestations of the purulent process were observed for more than four weeks in all the patients, which was an absolute indication for removal of infected implants.

Clinical, hematological, radiographic and microbiological studies were performed in all the patients in order to confirm the infection process and to clarify the nature of its course. Periprosthetic infection was classified according to D.T. Tsukayama, and knee bone defects according to AORI (Anderson Orthopedic Research Institute, USA).

The AORI classification defines the following types of bone defects [10, 11, 12, 13]:

Type I (F1 and T1): minimal spongy bone tissue defect in the metaphysis of the femur

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and/or tibia without damage to the collateral ligaments;

Type II (F2A or T2A): unilateral loss of spongy and cortical bone tissue of the femur and/or tibia; (F2B and T2B) - bilateral loss of spongy and cortical bone tissue of the femur and/or tibia;

Type III (F3 and T3): pronounced loss of spongy and cortical bone tissue with damage to the collateral ligaments.

During the operation, after spinal anesthesia and patient positioning, the surgical field was treated. Tight filling with an indicator (diluted brilliant green solution) was used in the presence of wounds or fistulas to visualize purulent pockets. Surgical approach to the infected joint was conducted using the known methods. All components of implants and remnants of bone cement were carefully removed with the help of revision tools. Next, a radical debridement of the infection focus, co-aptation of the resected bone fragments, followed by fixation of the femur and tibia with the Ilizarov apparatus (**Fig. 1**) was carried out. The operation was completed with drainage of the joint and layer-by-layer wound closure.

A course of etiotropic therapy (antimicrobial and/or antifungal) was prescribed for 2-3 weeks; it was corrected upon the results of microbiological study of the material harvested intraoperatively.

Patients were mobilized on the second day after surgery by an exercise therapy instructor. Sutures were removed 14–17 days after surgery. During the entire fixation period, compression was realized with the Ilizarov apparatus at the level of the docking of the resected fragments of the femur and tibia. The average fixation period was 4.62 ± 1.13 months (range: 2 to 10 months). The average duration of inpatient stay was 121.1 ± 13.56 days.

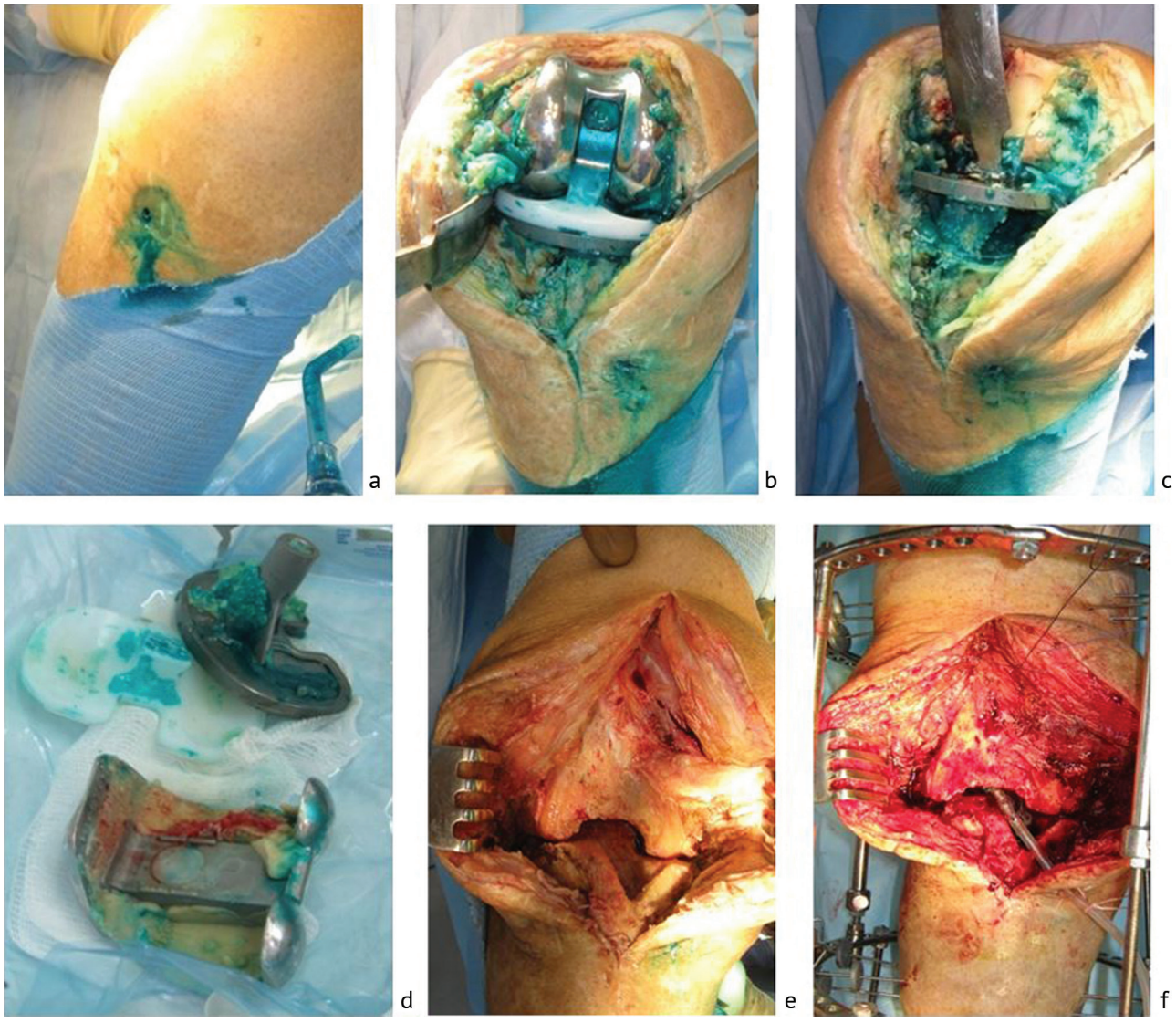

Fig. 1 Stages of knee joint arthrodesis using the Ilizarov apparatus: ***a*** filling with brilliant blue; ***b*** surgical approach to the infected joint; ***c*** removal of implant components; ***d*** components of the implant removed; ***e*** co-aptation of bone fragments; ***f*** fixation of the femur and tibia with the Ilizarov apparatus

The following criteria were used for evaluation of treatment results in patients with periprosthetic infection of the knee joint using the method of arthrodesis: suppression of the purulent process and ankylosis quality. The functioning of the joint in most patients was poor due to the lack of articulation (according to the Knee Society Score scale)

The treatment results in 63 patients were analyzed after three to 13 years; the average follow-up was 8 ± 2.72 years. Statistical processing used Microsoft Excel software with the calculation of the mean value and statistical deviation. The study was approved by the ethics committee in accordance with the standards of the 1975 Helsinki Declaration, revised in 2008.

RESULTS

Clinical examination showed that 56 (89 %) patients had sinuses, five (8 %) had wounds. Edema and hyperemia of the postoperative suture was detected in two (3 %) patients.

Defects of the bones of the knee joint were classified according to AORI and were assessed after the removal of implant components and surgical debridement in order to obtain the true bone deficit sizes. The data are presented in Table 1.

Defects of the knee joint of type I were observed in 27 % of cases, unilateral and bilateral defects of type II made up 25 % and 27 %, respectively, and type III was detected in 27 % of patients.

A microbiological study of the intraoperative biomaterial in 63 patients showed that 43 (68 %) patients had gram-positive microflora in the monoculture, one patient (2 %) had gram-negative microflora in the monoculture, and 19 (30 %) patients had microbial associations. The species of bacteria are presented in Table 2.

We evaluated the results of treatment of patients with periprosthetic infection of the knee joint using the method of arthrodesis based on the following criteria: degree of suppression of the purulent inflammatory process and completeness of ankylosis. The data are presented in Table 3.

Table 1

Bone tissue condition in patients with periprosthetic infection of the knee joint after removal of the implant and surgical debridement

AORI defect type	Number of patients	%
Type I (F1 и T1)	13	21
Type II (F2**A** и T2**A**)	18	28
Type II (F2**B** и T2**B**)	15	24
Type III (F3 и T3)	17	27
Total	63	100

Table 2

Microbial strains in patients with periprosthetic infection after knee arthroplasty

Family	Genus and species of bacteria	Number	%
Staphylococcaceae	*MRSA, MRSE, MRSH, MRSC*	16	72
	S. aureus	32	
	S. epidermidis	8	
	S. hominis	2	
Enterococcaceae	*Enterococcus faecalis*	8	12
	Enterococcus species	2	
Corynebacteriaceae		*2*	2.5
Enterobacteriaceae	*Enterobacter cloacae*	1	7
	Serratia marcescens	1	
	Enterobacter cloacae БЛРС	3	
	Klebsiella pneumoniae БЛРС	1	
Pseudomonadaceae	*Pseudomonas aeruginosa*	2	2.5
Moraxellaceae	*Acinetobacter baumannii*	3	4
Total		81	100

Table 3

Assessment of the results in patients with periprosthetic infection of the knee joint with arthrodesis technique

Infection arrest		Arthrodesis outcome		
Infection arrest	Infection recurrence	Ankylosis	Pseudarthrosis	Amputation
46 (73 %)	17 (27 %)	46 (73 %)	15 (24 %)	2 (3 %)
Total 63 (100 %)		Total 63 (100 %)		

The table shows that after removing the infected knee joint implants and arthrodesis using the Ilizarov apparatus it was possible to arrest infection in 46 (73 %) patients. However, seventeen (27 %) had infection recurrence. Twelve patients with early recurrence had joint debridement without re-resection, one had re-arthrodesis, two patients had femur amputation (one of which died due to sepsis), and two more died due to sepsis one year after surgery.

Consolidation of the knee joint fragments from the first arthrodesis procedure was achieved in 73 % of cases. It should be noted that 17 (27 %) patients with pseudarthrosis of the knee joint and amputated limbs had the following types of defects initially: type I in two patients, type II (F2A and T2A) in four individuals, type II (F2B and T2B) in six patients, and five patients had type III.

DISCUSSION

Arthrodesis for periprosthetic infection is a forced measure in cases of failed revisions aimed at preserving the implant [2, 7, 14, 15]. In the foreign and domestic literature, various osteosynthesis options were presented. The most popular of them are intramedullary nails and the external fixation devices. The success of arthrodesis in the conditions of purulent infection depends on the quality of surgical debridement, activity of the inflammatory process, size of bone defects, associated diseases and type of osteosynthesis used [4, 6, 9, 16].

We considered expedient to compare the results of knee arthrodesis in the treatment of periprosthetic infection, depending on the size of bone defects, using the Ilizarov apparatus as an osteosynthesis means in all patients. The patients were divided into groups according to AORI (Table 4).

These data demonstrate the direct dependence of knee arthrodesis on the size of bone defect. If the size of defects corresponds to type I or II (F2A and T2A) according to AORI, then infection and ankylosis of the knee joint may be achieved in 84.6 %, and in 77.7 % the discrepancy in limb length does not exceed an average of 3.6 cm (**Fig. 2**).

Table 4

Results of treatment in patients with periprosthetic infection of the knee joint with the method of arthrodesis and their dependence on types of defects according to AORI

AORI defect type	Treatment result		
	Arrest of infection	Ankylosis completeness	Mean limb discrepancy (cm)
Type I (F1 и T1)	84.6 %	84.6 %	3.6 ± 0.65 (от 3 до 5)
Type II (F2A и T2A)	77.7 %	77.7 %	3.4 ± 0.79 (от 3 до 6)
Type II (F2B и T2B)	60 %	60 %	3.9 ± 1.07 (от 3 до 6)
Type III (F3 и T3)	70.5 %	70.5 %	7.5 ± 5.15 (от 5 до 24)
Mean value	73 %	73 %	4.6 ± 1.91

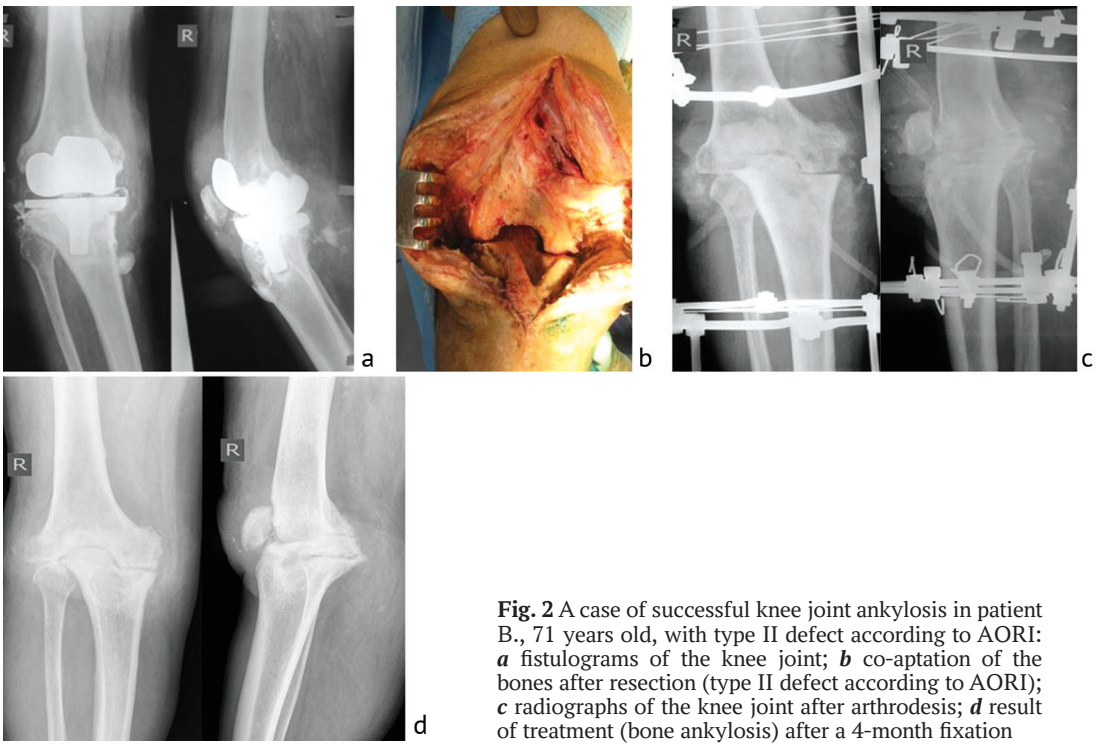

Fig. 2 A case of successful knee joint ankylosis in patient B., 71 years old, with type II defect according to AORI: ***a*** fistulograms of the knee joint; ***b*** co-aptation of the bones after resection (type II defect according to AORI); ***c*** radiographs of the knee joint after arthrodesis; ***d*** result of treatment (bone ankylosis) after a 4-month fixation

If the size of the defect corresponds to types II (F2B and T2B) or III according to AORI, then the infection eradication rate and successful ankylosis of the knee articulation was achieved in 60 % and 70.5 % with shortening exceeding 3.9 cm on average (**Fig. 3**).

Better results of knee joint arthrodesis performed with transosseous osteosynthesis in patients with periprosthetic infection can be achieved in types I and II (F2A and T2A) according to AORI. It seems that in types II (F2B and T2B) and III, it is more expedient to use arthrodesis implants with diaphyseal fixation, which will shorten the rehabilitation period and inpatient stay, as well as will improve the limb support function and adjust the limb length.

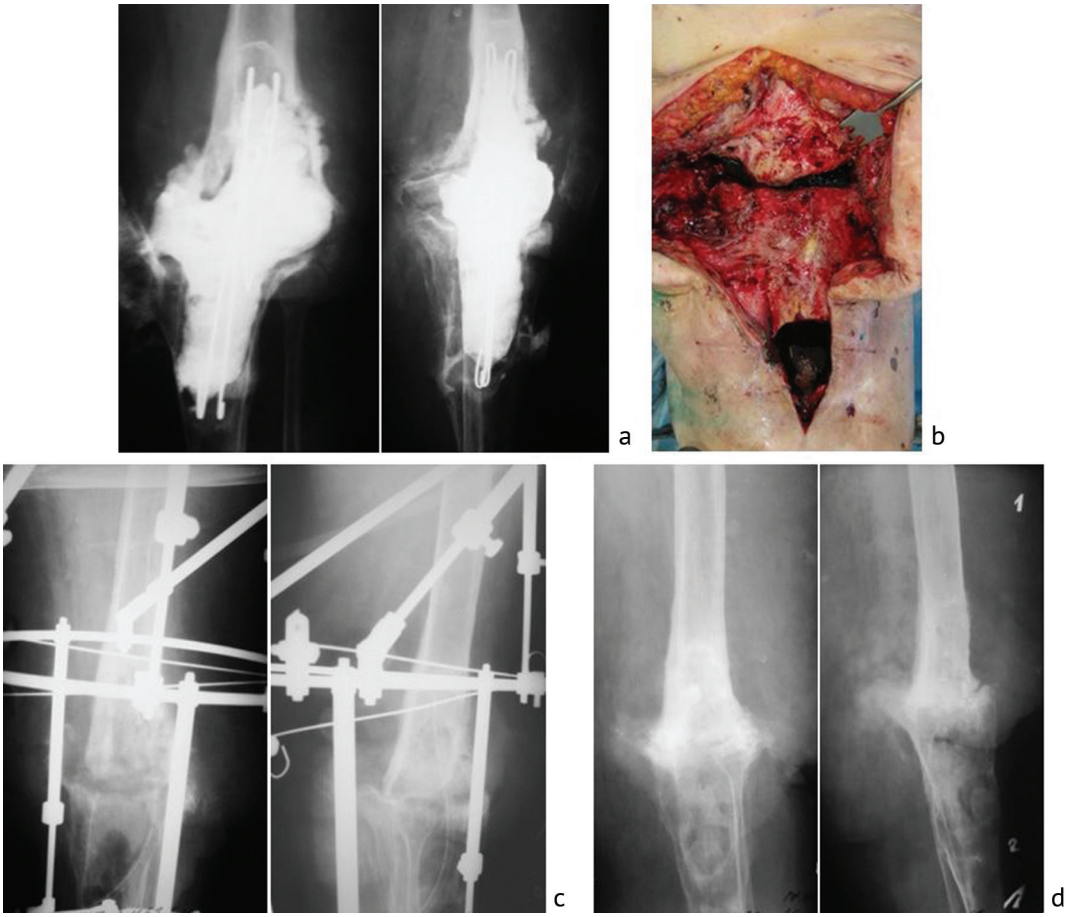

Fig. 3 An example of failed ankylosis (pseudarthrosis) of the knee joint in patient V., 63 years old, with defect type III according to AORI: ***a*** fistulograms of the knee joint; ***b*** co-aptation of the bones after resection (type III defect according to AORI); ***c*** radiographs of the knee joint after arthrodesis; ***d*** result of treatment (pseudarthrosis), 4.3 months of fixation

CONCLUSION

Arthrodesis of the knee using the Ilizarov apparatus in patients with periprosthetic infection is able to arrest the purulent process in 73 % of cases with a recurrence rate of 27 %. Consolidation of the knee joint fragments was observed in 73 % of patients from the first attempt of arthrodesis.

No conflict of interest is declared.

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