Flaps for closure of soft tissue defects in infected revision knee arthroplasty

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Abstract

Purpose Total knee arthroplasty revision has wound healing deficits of up to 20 %. Defects in the knee region of multimorbid patients are hard to treat as complete explantation and revision arthroplasty is often too burdensome for them. In this study, we present our results with flaps for the treatment of defects after knee replacement, arthrodesis or osteosynthesis. **Methods** Twenty-five patients (26 knees) with defects in the knee region were treated with flaps. Mean follow-up was 37 months (13–61) and the patients had a mean age of 72 years (49–85). A total of 39 flaps were performed (27 muscle flaps, seven fascio-cutaneous flaps and five free flaps). **Results** Patients with more than three comorbidities showed higher risk of complications after surgery. Fifteen patients showed no infection at last follow up. Five patients received an arthrodesis of the knee, two showed persistent infection of the implant with fistula, and three were amputated above the knee. **Conclusions** Amputation could be avoided in 22 cases (85 %). The gastrocnemius muscle flap showed good results in the treatment of defects after arthroplasty or arthrodesis of the knee in multimorbid patients. This procedure can be used if further revision surgery is not indicated.

Keywords Soft tissue defect · Flaps · Revision knee arthroplasty · Infected knee arthroplasty

Introduction

After total knee replacement and revision total knee replacement (TKR) soft tissue defects with exposed bone or implant and subsequent infection can be seen in 5–20 % of cases [1, 2]. Several risk factors are known for developing wound-healing problems. Diabetes and smoking show a high risk for wound-healing problems especially after orthopaedic surgery [3–7]. Medial surgical incisions also have higher risk for wound healing problems due to the skin-blood nutrition provided from the lateral side in the knee joint region [8]. A surgical procedure >2.5 hours and the use of a tourniquet with pressure 350 mmHg and higher is associated with a higher risk of wound healing problems [4, 9–11].

Postoperative hematoma leads to increasing tension in the incision area with a significant risk of insufficient scars. Using a drain reduces the risk of hematoma but increases the risk of infection at the same time if the drain is not removed after 24 hours postoperatively [4, 12–15]. Adiposity and postoperative antithrombotics prolong postoperative wound secretion after arthroplasty, which is a risk factor for infection [12, 16, 17].

If a TKR is diagnosed as infected and a soft tissue defect is present, a surgical intervention should follow as soon as possible. In combination with antibiotics, good long-term results can be achieved [18, 19]. Bacterial eradication in a persisting prosthetic infection can only be done by removal of the prosthesis and radical debridement—in one-stage or two-stage procedures [20]. For total hip replacement, the vastus medialis muscle flap is a good treatment option after implant removal [21]. In multimorbid patients with reduced general state of health and chronic TKR infection, a two-stage procedure is advantageous because of poor bone quality, soft tissue problems or multiresistant bacteria [22]. Serious consideration should therefore be given to alternatives for this procedure because these patients are often not suitable for multiple burdensome operations. The same applies to patients with

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bone defects, insufficient quadriceps or patellar tendon and immune deficiency. Arthrodesis can provide loadable and painless lower limb without amputation and should be considered in these cases [23]. Quality of life is significantly better in patients with arthrodesis than in amputees [24]. For soft tissue defects, the medial gastrocnemius muscle-flap is frequently used and seems to be the most appropriate option in these cases [25].

The aim of this study was to find out if flaps can achieve implant preservation in multimorbid patients with soft tissue defects after TKR or arthrodesis, when a revision TKR is not indicated or is not wanted due to comorbidities. Other aims were to find out which flap is reliable and in which patients the implant cannot be preserved.

Materials and methods

All patients who had soft tissue defects after TKR, arthrodesis or osteosynthesis and who received a flap between September 2007 and December 2011 were included in this exploratory retrospective study. Demographic data, comorbidities, blood cell count, antibiotic therapy, former surgeries and complications were evaluated for each patient. In one case, no follow-up data could be evaluated. Twenty-five patients (26 knees) were treated with a flap for defects after arthroplasty, arthrodesis or osteosynthesis in the knee joint region. The surgery took place at BG Trauma Center Ludwigshafen, Germany. The mean follow-up was 37.3 months (range 13–61). We evaluated 11 women and 14 men with a mean age of 72 years (49 to 85) at the time of operation. The mean BMI was 27 kg/m², 16 patients were obese and seven had adiposity. Our patients had a high number of comorbidities (Table 1). A total of 23 patients had previously been treated for arthroplasty, 17 for primary osteoarthritis, four for post traumatic osteoarthritis and two for rheumatoid arthritis. Seven patients had early infection after arthroplasty with soft tissue defect. Figure 1 shows a “reflexion-test positive” knee with a soft tissue defect after TKR. In four patients, the prosthesis could be preserved, in two patients, a two-stage revision arthroplasty was performed and one patient received an arthrodesis with external fixator. In 17 patients, the infected arthroplasty was removed and a spacer was implanted. The flap was performed in the same procedure with revision arthroplasty ($n=4$) or later ($n=5$) between one and eight weeks after the first procedure. Eight of these patients had revision arthroplasty before and arthrodesis was performed. The flap was done in the same procedure ($n=6$) or later ($n=2$).

Two patients received a lateral gastrocnemius muscle flap after an infected osteosynthesis – one with a locking plate on the lateral proximal tibia, one with a locking plate on the lateral distal femur. Overall, 15 patients received a flap for a soft tissue defect after knee arthroplasty, nine after arthrodesis

Table 1 Comorbidities of patients with flaps

Comorbidity	Number of patients
Arterial hypertension	16
Adiposity	7
Coronary heart disease	7
Renal insufficiency	5
Diabetes mellitus	4
Lipid metabolic disorder	4
Cardiac arrhythmia	4
Chronic obstructive pulmonary disease	3
Heavy smoking	3
Cardiac insufficiency	2
Peripheral arterial disease	2
Rheumatoid arthritis	2
Alcoholic	1

and two after osteosynthesis. The correct treatment for the soft tissue defect was chosen using the classification by Laing et al. [26]. Table 2 shows our decision-making based on this classification and the treatment for the defects.

Results

A total of 38 flaps were performed: 26 pediculated muscle flaps (18 medial and eight lateral gastrocnemius muscle flaps, respectively), five free flaps (three latissimus dorsi and two ALT) and seven fasciocutaneous flaps (three pivoted flaps and two rotation flaps and two shift flaps, respectively). Nine patients required a second flap and three patients needed three or more flaps (Table 3). One case was lost to follow-up.

The mean period of hospitalisation was 87 days (range, 28–186). Patients with a free flap stayed on average 112 days longer in hospital compared to patients with muscle flaps (55 and 167 days, respectively). On the day they presented at our hospital, 20 patients showed signs of infection in the blood cell count (CRP >10 mg/l or leucocytosis >10,000/μl). Five

Fig. 1 “Reflexion-test positive” soft tissue defect after total knee replacement (TKR)

Table 2 Treatment according to Laing et al.

Lesions	Defect	Minimal treatment
Lesion stage 1	Skin necrosis, <4 cm	Split skin graft, VAC [24]
Lesion stage 2	Deep layers affected, >4 cm	Local flap, VY [24, 25]
Lesion stage 3	Deep wound dehiscence	Muscle flap [5, 17, 23, 25–33]
Lesion stage 4	Obvious prosthesis exposure	Free flaps [34, 35]

patients showed no signs of infection. Figure 2 shows the complications that occurred. Looking at the comorbidities, patients with arterial hypertension or diabetes showed the highest revision rate (Fig. 3).

Six muscle flaps (four medial and two lateral gastrocnemius muscle flaps), two ALT and one fasciocutaneous flap required revision with four mesh grafts, two local fasciocutaneous flaps, two lateral gastrocnemius muscle flaps and one latissimus dorsi free flap.

Only one patient with one comorbidity had soft tissue closure again with mesh graft. Seven patients with three or more comorbidities (all including arterial hypertension and/or diabetes) needed a fasciocutaneous or muscle flap. Enterococcus (11), Enterobacteriaceae and coagulase-negative Staphylococci (both eight), *Staphylococcus aureus* (four), *Pseudomonas aeruginosa* and Streptococci (both three) and MRSA (two) could be detected in soft tissue specimen. In ten cases, no bacteria could be detected, in 22 cases only one pathogen could be detected, and in six cases more than one pathogen was detected. Appropriate antibiotic therapy was given for a mean period of four weeks (two to eight weeks) in all cases. With a pediculated muscle flap, implant preservation could be achieved in 12 patients (Fig. 4). In five patients, arthrodesis was indicated, one patient had to be amputated above the knee and another patient was treated with persistent fistula. With a free flap, implant preservation could be achieved in two patients, one patient was treated with persistent fistula and another patient had above knee amputation.

In all six patients with one relevant comorbidity the implant could be preserved. Three of the six patients with two comorbidities had implant preservation, two received arthrodesis and one amputation. In six of the 13 patients with more than three comorbidities, the implant could be preserved, three received an arthrodesis and in two persistent fistula or amputation was performed. Looking at the nine patients without implant preservation, 75 % of these patients had multiple relevant comorbidities (Table 4).

Discussion

The optimal treatment of soft tissue defects after TKR is subject to discussion and few studies are available in

the literature other than case series or case reports [19, 27–30].

In this study, limb preservation after flaps for soft tissue defects following TKR, arthrodesis or osteosynthesis in the knee region in 26 knees could be achieved in 85 % of cases. This is similar to the results of the case series and case reports [19, 29, 31, 32]. However, in 15 patients, infection control could be gained and the implant could be preserved. In 22 patients, amputation could be avoided. More than 50 % of the patients in this study had three or more relevant comorbidities. Our results suggest that even in these patients amputation can be avoided using flaps for the closure of soft tissue defects. In 12 patients who received a pediculated muscle flap, the implant could be preserved. In six patients with a pediculated muscle flap, amputation could be avoided but arthrodesis was performed. For six pediculated muscle flaps (three medial and three lateral gastrocnemius muscle flaps) a single revision surgery was performed, five with local debridement and one with vacuum-assisted closure. Complications are well known for these flaps [19, 25, 28, 33]. Four medial and two lateral gastrocnemius muscle flaps required two revisions, three with another necrosectomy and mesh graft and two with fasciocutaneous flaps. In one patient, a latissimus dorsi flap was performed. Our results support the evidence in the literature that muscle flaps are the best treatment option for defects with implants due to excellent nutrition and vascularisation [25, 32]. If the flap fails, free flaps can still solve the problem. The five free flaps in our study led to infection control in two cases. Above knee amputation had to be performed in two cases and one patient was treated with chronic fistula. Limb preservation could therefore be achieved in three of the five patients. In three cases (two ALT, one latissimus dorsi), revision with extraction of hematoma was necessary. In another latissimus dorsi flap a second revision was performed. One ALT was revised three times because of partial necrosis. ALT flaps gave a below-average performance in our study.

With early debridement and closure of the defect, implant preservation can be achieved, which Nahabedian et al. and Menderes et al. had previously demonstrated [28, 29]. However, Chandrasekhar et al. recommend another procedure and the removal of the implant [34].

Table 3 Patients with flaps performed and complications related to BMI and comorbidities

Age (years)	Sex	BMI	Relevant comorbidities	Number of previous operations	Diagnosis	Treatment	Complications	Number of revisions	Further therapy
66	F	54	3	2	Arthrodesis	Fasciocutaneous flap		0	
62	M	27	0	5	Arthrodesis	Medial gastroc. flap		0	
75	M	27	2	3	Revision TKR	Medial gastroc. flap		0	
74	F	42	4	1	TKR	Medial gastroc. flap		0	
69	M	30	2	2	Revision TKR	Med/lat. gastroc. flap		0	
74	F	26	4	6	Arthrodesis	Med. gastroc. flap		0	
61	M	29	0	2	TKR	Lat. gastroc. flap		0	
78	F	28	2	4	Revision TKR	Med. gastroc. flap		0	
70	F	20	4	6	Revision TKR left	Med. gastroc. flap		0	
					Arthrodesis right	Med. gastroc. flap		0	
72	M	26	1	3	Revision TKR/spacer	Med. gastroc. flap			Revision TKR
69	F	32	1	2	Revision TKR/spacer	Lat. gastroc. flap and arthrodesis	Minor	2	
74	M	33	7	3	Revision TKR/spacer	Medial gastroc. flap and arthrodesis	Minor	1	
49	M	25	0	3	Revision TKR/spacer	Me. gastroc. flap and arthrodesis	Minor	1	Fasciocutaneous flap
53	F	52	2	2	Revision TKR	Me. gastroc. flap	Minor	1	Fasciocutaneous flap
65	F	29	4	3	Arthrodesis	Lat. gastroc. flap	Minor	1	Fasciocutaneous flap
81	F	26	3	6	Arthrodesis	Lat. gastroc. flap	Minor	1	Fasciocutaneous flap
49	M	24	4	1	Locking plate for proximal tibia fracture	Lat. gastroc. flap	Minor	2	Arthrodesis
50	M	29	1	5	Arthrodesis	Medial gastroc. flap	Persistent infection	2	1. Fasciocutaneous flap 2. Latissimus dorsi free flap
74	M	34	3	4	Revision TKR	Med. gastroc. flap	Persistent infection	1	Latissimus dorsi free flap
78	F	29	2	4	Revision TKR	Medial gastroc. flap	Persistent infection	2	Above knee amputation
72	M	27	1	4	Revision TKR/ spacer	Med. gastroc. flap and arthrodesis	Major	2	Lat. gastroc. flap
79	M	27	3	4	Arthrodesis	Med. gastroc. flap	Major	5	1. Latissimus dorsi free flap 2. Chronic fistula
71	F	26	2	2	Revision TKR	ALT	Major	4	Above knee amputation
					Revision TKR	Med. gastroc. flap	Major	5	1. Fasciocutaneous flap 2. ALT and arthrodesis 3. Lat. gastroc. flap 4. Above knee amputation

Fig. 2 Minor complications occurred and treatment

Fig. 3 Complications after flap surgery related to the main comorbidities occurred in the collective

There is a consensus in the literature that implants with chronic infection should be removed, mostly in a two-stage procedure [19, 27]. In our study, this was our successful protocol as well.

Fifty percent of the patients with three or more relevant comorbidities required revision surgery and 75 % of patients who required another flap had three or more relevant comorbidities. This was known for head-neck tumour surgery or free flaps in elderly patients [35]. Our study shows for the first time that these results are similar to patients with flaps for defects in the knee region.

In all patients with one relevant comorbidity the implant could be preserved. In patients with two or three comorbidities this was possible in 50 % of cases.

In nine patients, arthrodesis (five), open fistula (two) and amputation (three) had to be performed. Seventy-five percent of these patients had three or more relevant comorbidities. None of these patients had arterial hypertension or diabetes. Most studies with small numbers of younger patients report up to 100 % implant preservation [27]. Patients in our study receiving arthrodesis were almost 70 years old. Only one study with patients of a comparable age shows similar results [33]. Arthrodesis is indeed an alternative to achieving a stable lower limb with reduced pain. The three amputations in our study differ from those reported in the literature. Whereas the indication is mostly set for life-threatening conditions, like

septic shock or massive pain, and limb preservation could be achieved in all patients, the three patients in our study refused to receive another free flap and opted instead for amputation, similar to Gerwin et al. [19, 27–30]. One limitation of this study is the lack of homogeneity among our patients regarding age and comorbidities so that different flap procedures might not be comparable. Another limitation is the lack of homogeneity regarding the primary diagnosis. Patients with the second revision-TKR and patients after osteosynthesis of the proximal tibia were included in this study because they received a flap for a soft tissue defect in the knee region. However, we found the number of previous operations is not a factor for complications. Our results demonstrate that early soft tissue reconstruction can preserve implants with defects in the knee region. Pediculated muscle flaps are the best option and minor complications of these flaps can be handled easily. Free flaps can preserve implants as well but ALT was not a successful procedure in our patients. Muscle flaps should be “gold standard” for first-time defects, even in multimorbid patients. Arthrodesis is another alternative to gain a loadable and painless limb in patients with a high risk of reinfection. However, a fast surgical reconstruction of the soft tissue defect with a simple and safe surgical procedure avoids further problems. With successful sanitation of the soft tissues the patient can be spared from further complications, arthrodesis or amputation.

Fig. 4 Results 12 days after pediculated lateral gastrocnemius flap

Table 4 Patients without implant preservation and their comorbidities

Comorbidity	≥3 comorbidities	Arterial hypertension	Diabetes mellitus	Peripheral arterial disease
Arthrodesis	3/5	4/5	1/5	0/5
Persistent fistula	2/2	2/2	2/2	0/2
Above knee amputation	2/3	3/3	0/3	1/3

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