Surgical reconstruction in diabetic foot syndrome

Considerable morbidity upon spontaneous wound healing (phlegmons, osteomyelitis, and purulent osteoarthritis of metatarsophalangeal joint) as well as loss of the diseased foot’s walking ability are among the reasons for transition to plastic surgery in management tactics. The longer foot lesion persists, the higher probability of amputation. Improvement of treatment of both wound and ulcer lesions by means of reconstructive surgery in patients with diabetic foot syndrome was the main aim of the study. Outcomes of treatment of 460 patients managed at the Center for the Scientific and Clinical Study of Endocrinology, within the period from 2001 to 2009 were analyzed. Size, form, depth and localization of a wound, tissue composition of the wound bed as well as circulation in skin flaps caused the choice of specific operation: autodermoplasty by Parin (with the split-thickness skin flap), local tissue plastic operation (with the sliding or inter-advancing skin flaps, flaps from previously amputated toe or Indian flaps), plastic operation with the controlled tissue tension or combined plastic operation. Reconstructive foot wound surgery allows restoring load-bearing function of the extremity much earlier in contrast to spontaneous healing, reducing incidence of post-operative and long-term complications, amputations and re-amputations, decreasing period of treatment.

Keywords: Diabetic foot syndrome, reconstructive surgery, wound closure.

UDC: 616.379-008.64-06+617.586-089.444

Introduction

Diabetes mellitus (DM) is a chronic disease with annually increasing incidence and prevalence. According to WHO there were nearly 190 million of persons with diabetes mellitus in 2003 worldwide, prognosis for 2025 estimates further increase to 380 million. Diabetic foot syndrome (DFS) is a DM complication of the greatest concern (Bregovsky et al., 2004; Dedov et al., 2005; International Consensus on Diabetic Foot, 2000).

Surgical reconstruction for DFS necrotic suppurative lesions inevitably results in foot wounds and ulcers of various localization, depth and area. Prolonged duration, high invalidity and post-operative mortality make DFS most significant medico-social problem requiring new methods of treatment (Nikitin et al., 2001; Tokmakova et al., 2003).

Recent rapid introduction of plastic operations into medical practice has qualitatively changed the outcomes of management of necrotic suppurative processes (PNP) in patients with diabetic foot syndrome, not only significant reduction in ulcer healing duration but also improvement in functional outcomes of the surgery being achieved (Amiraslanov et al., 1990; Goryunov et al., 2004; Grishkevich et al., 1989; Ermolov et al., 1998; Ermolov et al., 1998).

Considerable morbidity upon spontaneous wound healing (phlegmons, osteomyelitis, and purulent osteoarthritis of metatarsophalangeal joint) as well as loss of the diseased foot’s walking ability is among the reasons for transition to plastic surgery in management tactics. The longer foot lesion persists, the higher probability of amputation exists.

Improvement of treatment of both wound and ulcer lesions by means of reconstructive surgery in DFS patients was the main aim of the study.
Material and methods

We analyzed outcomes of treatment of 460 patients managed at the tertiary referral center, Center for the Scientific and Clinical Study of Endocrinology (Uzbekistan), within the period from 2001 to 2009. All these patients had wound and ulcer lesions formed as a result of treatment of necrotic suppurative DFS complications.

The examinees were divided into two groups by management tactics. Three hundred fifty five patients (272 men, 76.6%; 83 women, 23.4%) undergoing plastic wound closure were included into the experimental group. The control group comprised one hundred five patients (68 men, 64.7%, 37 women, 35.3%) undergoing open wound management. The patients’ age varied from 35 to 72 years (mean age 57.3±0.72), the diabetes duration ranging from 5 to 30. Type 1 diabetes mellitus was diagnosed in 22 (4.7%), 448 patients (95.3%) had type 2 diabetes mellitus.

Diabetic retinopathy, diabetic nephropathy or their combination were registered in all examinees. As a comorbidity, ischemic heart disease (IHD) was observed in 25% of all cases.

Diabetic retinopathy, diabetic nephropathy or their combination were registered in all examinees. As a comorbidity, ischemic heart disease (IHD) was observed in 25% of all cases.

Medical history of foot ulcers and foot deformity was found in 428 (93.2%) and 335 (72.9%) respectively. According to Wagner’s classification (1979) there were 9 (2.1%), 185 (40.2%) and 266 (57.7%) patients of II, III and IV categories, respectively. The wound area varied from 25 to 320 cm², mean area being 48.0 ± 4.21 cm². Upon hospitalization all patients had DM decompensation, combined therapy provided subcompensation or compensation. Provided with control of Glycemic profile all patients were transferred to insulin therapy.

Among 355 patients of the 1st group toe gangrene with the foot phlegmon was registered in 219 (61.6%), 17 persons (4.8%) had purulent wound of heel; phlegmons of foot and shin were found in 99 (27.8%) patients; phlegmons of shin and thigh were in 12 (3.4%) examinees. 61% of the patients were hospitalized with a severely compromised health condition caused by prolonged purulent intoxication with the severe comorbidity.

54 controls (53.5%) had toe gangrene with foot phlegmon, 29 (28.5%) had phlegmons of foot and shin, and 15 (15%) patients had phlegmons of shin and thigh. In 7.3% of patients there was a suppurative process in the heel. Grave health condition was registered in 61.5%.

Our department tactics for management of patients with lower extremity necrotic suppurative lesions included: diabetes mellitus compensation; combined medical treatment; complete unloading of the extremity; arterial blood flow restoration (transluminal balloon angioplasty and stenting of lower extremity's vessels); sharp debridement of a suppurative focus; reconstructive closure of wounds.

All controls underwent open post-operative wound management, including daily bandaged with water-soluble ointments, proteolytic enzymes and antiseptics.

Decision on surgical reconstruction in the experimental group patients with various DFS forms considered assessments of various conditions: wound process; blood circulation by Doppler- and duplex scanning, transcutaneous oxygen pressure measurement (TcPO2) after multi-spiral computer tomography; wound exudate culturing.

Properly formed foot or its stump is required to avoid foot subsequent deformities being the second important aspect after sharp debridement of wound or ulcer at the II stage of the wound process. Reconstructive surgery is an expedient completion of DFS surgical treatment. Indications for plasty include: compensation of diabetes mellitus and stabilization of patient’s general well-being; sufficient perfusion of the extremity’s soft tissues and appearance of active granulations; arrest of purulent inflammation.

Size, form, depth and localization of a wound, tissue composition of the wound bed as well as circulation in skin flaps underlie the choice of method.
Contraindications for plasty include: decompensated diabetes mellitus; comorbidity-associated general well-being; presence of infection and ischemic alterations in the wound and surrounding tissues.

The operation should be performed with complete wound closure and is defined by form, area and localization of the lesion. For post-debridement wounds with expansive areas to be primarily or early closed as well as for soft tissue substitution we perform any of following methods:

1. Split-skin grafting (autodermoplasty by Parin);
2. Local tissue plastic operation (with the sliding or inter-advancing skin flaps, flaps from previously amputated toe or Indian flaps);
3. Plastic operation with the controlled tissue tension;
4. Combined plastic operation.

Wound debridement - surgery period varied from 3 to 6 weeks. In the experimental group we performed 251 (70.7%) local tissue plastic operations, 50 (14.1%) split-skin graftings, 30 (8.4%) plastic operations with the controlled tissue tension, 23 (6.5%) combined plastic operations and one Italian plasty.

Presence of wounds with the bed of bone structures, joints, tendons, fasciae as well as lesions of the foot load-bearing area and in places subject to the highest pressure are the indications for the local tissue plastic operation. This type of surgery is used whenever wounds are to be closed by sliding, inter-advancing or rotation of the foot cellulocutaneous flaps with adaptation of the tissues with sutures avoiding extreme (critical) tension. It can be a single-step operation or as the result of the controlled tissue tension.

Opportunities for skin plastic surgery are limited since ischemic manifestations cannot be easily arrested, risk of inflammation recurrences preserving in the area of lesions. Tension of the mobilized flaps necessitates prudent resection of metatarsal and other bones to provide better flap-to-flap adaptation and to facilitate complete closure of wound or ulcer lesion. The surgery was performed in 59 patients. Deep wounds in 72 patients required tamponade of wound cavity with deepithalialized cellulocutaneous flap with active aspiration. To close trophic plantar ulcer in 6 patients (1.7%) a cellulocutaneous toe flap, primarily amputated for osteomyelitis, was used.

50 patients (14.1%) underwent autodermoplastic operation by Parin. Localization of lesions on non-load-bearing surfaces of the foot, expansive and local lesions of the foot nor liable to be closed by local tissue plasty, as well as residual lesions arising from the combined skin plastic operations are among the indications for the operation.

The combined skin plastic surgery was performed in 23 patients (6.5%) with expansive foot lesions. Foot lesions not liable to be closed by local tissues only are indications for the operation. Foot load-bearing surfaces as well as bone and joint surfaces are closed with the mobilized cellulocutaneous or fasciocutaneous local tissues. Non-perforated split-thickness flap is used to close non-load-bearing surface lesions in case of foot tissues lack.

Plastic surgery with the controlled tissue tension was performed in 30 cases (8.4%). The method makes possible early closure of expansive defects with congenial proper skin flap. Tissue tension is performed immediately after sharp debridement. To perform this we used a vertical bow-tied “IT”-like suture put with thick thread close to edges of expansively mobilized cellulocutaneous flaps (Amiraslanov et al., 1990). The sutures are pulled daily or every other day until complete wound edge adaptation.

Results

Within the period from 2003 to 2009 we performed 355 plastic operations in DFS patients with ulcer and wound lesions, in 221 patients (62.5%) wound healing by first intention was noted. Partial post-operative separation necessitated wound healing by
secondary intention in 107 examinees. Complete or partial pyosis was registered in 26 (7.2%). Wound healing for 251 local tissue plastic operations was found in 175 patients (69.9%) and in 47 (95%) of 50 plastic operations with the split-thickness skin flap.

In 20 patients (5.6%) with neuro-ischemic DFS (experimental group) surgical reconstruction followed adequate restoration of magistral circulation in the diseased extremity. Among these patients, wound healing by first intention occurred in 17 (4.8%), pyosis registered in 3 (0.8%).

Following plastic operations in experimental group post-operative ulcers came about in 6.3±0.9 weeks in the average. The operations appeared inefficient in 5 patients (1.6%) requiring lower extremity amputation due to pyosis in 28.6±1.7 weeks in the average.

In experimental group mean wound healing period was 19.0±3.2 days in contrast to 65±8.3 days in the control one. In 20 controls (19.6%) the process turned out chronic with ulceration unhealed for quite a long time. Following plastic operations no lethality was observed.

Wound healing by secondary intention was observed in 46% of controls (n=49) in 8-10 months. Necrotic suppuration and inefficient therapy required 21 (21%) transfemoral and 16 (15.8%) foot amputations, respectively. Cardio-vascular insufficiency was a cause of death in 18 patients (17.2%).

Patients of both groups were followed-up after 1-6 years for long-term complications. 48 (13.5%) patients of the experimental group showed complications. 1-2 years after local tissue plastic operation trophic ulcers appeared in 6 (2.4%), foot phlegmon was found in 3 (1.2%) patients. Toe, foot and thigh level amputations were to be performed in 3 (1.2%), 5 (2%) and 1 (0.4%) patients, respectively. There were 5 (2%) deaths because of cardiovascular insufficiency.

In 3-4 years four (1.6%) trophic ulcers and three (1.2%) foot phlegmons developed, 4 (1.4%) had toe amputations and 1 (0.4%) had amputation of the contralateral limb.

As to autodermoplasty by Parin, in 1-2 years there were 1 (2%) trophic ulcer, 1 (2%) midleg amputation due to necrotic suppuration, and 2 (4%) deaths because of cardio-vascular insufficiency. In 3-4 years trophic ulcer and foot phlegmon formed in 1 patient (2%), 1 (2%) foot and 2 (4%) shin amputations performed. One patient died, 6 years later a trophic ulcer was found in 1 patient.

Within 1-2-year follow-up after the combined plastic operation trophic ulcers formed in 2 (8.7%), one patient underwent toe amputation, two patients died. In 4 years contralateral shin was to be amputated in 1 person who died because of cardio-vascular insufficiency. 36-month follow-up showed limb salvation in 73.9% of patients.

**Conclusion**

In view of the findings we can conclude that the methods of reconstructive foot wound surgery allow restoring load-bearing function of the extremity much earlier in contrast to spontaneous healing. Patient’s general well-being as well as localization, depth and form of a wound underlie the choice of method. In addition, reconstructive surgery facilitates decrease of incidence of long-term complications, and amputations, as well as duration of treatment making reduction of complications and reaparations possible.

**References**


International Consensus on Diabetic Foot, 2000. [Mejdunarodnyi consensus po diabeticheskoi stope], in Russian, Moscow: Bereg
