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TREATMENT OF COMPLEX WAR WOUNDS OF THE LOWER LEG WITH FREE FLAPS AND ILIZAROV METHOD – OUR EXPERIENCE

SUMMARY

Indications for free flaps and Ilizarov method were severe bone fractures with extensive soft tissue defects and segmental bone defects longer than 4cm. The tissue defects of lower leg were classified as Gustillo IIIB and Gustillo IIIC. We used free flaps and Ilizarov method in treating 27 wounded subjects with vast tissue defects of lower leg at the Clinic of Plastic Surgery and Burns and Clinic of Traumatology and Orthopedic Surgery, with the aim of closing war wounds, covering deep structures and making the preconditions for later reconstruction of bone structures. Three months after the free flap transfer, we performed corticotomy and distraction of the longer (proximal or distal) bone segment of tibia. We analyzed types and time of free flaps applied, duration of the bone transport with Ilizarov apparatus, as well as the quality of reconstructed bone during the five-year follow-up. All of 27 patients that we treated with free flaps and Ilizarov procedure are able to walk independently without orthopedic devices, while the maximal shortening of the leg was 3 cm in 2 (7.4%) patients.

The combination of two revolutionary methods in plastic and orthopedic surgery, the free flap and Ilizarov method is a useful treatment modality, which finds place in treating the war wounds with the extensive tissue defects of the lower leg.

Key words: **war wound, free flap, Ilizarov method**

INTRODUCTION

War wounds are commonly associated with various tissue defects. Explosive devices predominate in the etiology of large tissue defects (1). According to the literature data sources (2), injury of the extremities predominate, which is confirmed with growing trends from the II World War (53%), Korea (53%), Vietnam (55%) war and «Desert Storm» (88.4%).

Most of the wounded during the war in former Yugoslavia (63.9%) were in their 3rd decade of life (3). Most of the wounded (3rd and 4th decade of life) belonged to group of very active population, with regenerative ability. The complexity of tissue defects demonstrated destructive power of the weapons used. Extensive injuries of the lower leg have been managed with long-term surgical treatment of soft tissue defects and some of the traditional reconstruction methods (local skin or muscle flaps, free or «cross leg» flaps). Several months after soft tissue defects and local infection have been resolved, bone tissue replacement was initiated. Injuries of the lower leg of Gustillo IIIB and IIIC types were associated with a high percentage of amputations.

Free flap transfer and Ilizarov bone transport were used for the first time in the ex-Yugoslav war in the management of war wounds.

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In accordance with war surgery doctrine, we applied both simple and complex free tissue flaps in order to obtain an adequate tissue envelope for the injured lower leg. Bone transport is a technique of distraction osteogenesis presented by Ilizarov in the treatment of long bone defects after tumor resection, injury or inborn deformities (4).

Four principal indications for the application of Ilizarov device are:

- Reposition and immobilization (stabilization) of injury site,
- Distraction of bone ends and soft tissue cover in order to establish appropriate extremity length,
- Distraction (transport) of cortical bone portion or recipient bone segment, and
- Compression in order to obtain primary arthrodesis at the site of bone transplant (5,6).

Structure, location and complexity of lower leg tissue defect require various free flap types to be applied. We analyzed the complexity of tissue defects, recipient blood vessels, types of microanastomosis, early and late complications of free tissue transfers, blood supply for free tissue transfer and duration of surgical treatment. Three months after free tissue transfer, Ilizarov method was utilized. In the five-year period of observation this study also investigated the time to removal of Ilizarov device, duration of tissue transport and quality of the reconstructed bone and functional treatment outcome.

MATERIAL AND METHODS

During the period 1991-1995, almost 2000 wounded were treated at the Clinic for Plastic Surgery and Burns and Clinic of Traumatology and Orthopedics, Military Medical Academy. Among them, 27 were treated with free flaps and Ilizarov method for war wounds of the lower leg, with spacious soft tissue and osseous tibial defects of over 4 cm.

Tissue defects were classified according to the Gustillo classification.

Treatment of the wounds with tissue defects was done according to the principles of war surgery doctrine.

Since all war wounds are primarily contaminated, all of the wounded had antitetanus protection and antibiotic therapy. For the closure of complex wounds with soft tissue and osseous defects, we used external fixation in co-operation with orthopedists. In order to reduce the operative time we performed a free tissue transfer with two surgical teams simultaneously; one of these elevated the flap and prepared flap blood vessels for microanastomosis; the other performed additional surgical treatment of the wound and prepared recipient blood vessels for microanastomosis. After wound closure with free flaps and management of soft tissue defect, orthopedic surgeons stabilized the injured lower leg with unilateral external fixation. Three months after the free flap application, orthopedic surgeons started the Ilizarov procedure with:

- Removal of the unilateral fixator and application of Ilizarov device,
- Corticotomy of the tibial end, and
- Bone transport of the cortical graft by Ilizarov.

After the circular Ilizarov frame (external fixator) has been put in place, tibial corticotomy is done through the longer tibial bone fragment (proximal, distal or both). Five days after corticotomy of the longer segment of injured tibia, bone transport is initiated gradually for defect distraction (1 mm a day) and compression of distal or proximal tibial segment. Distraction regeneration occurs between the proximal bone and transport segment. After the consolidation of distraction, regeneration and healing of the junction, the device is removed. We utilized the so-called Ilizarov monofocal compression osteosynthesis with fibular resection, if this was necessary in cases of unsuccessful union of the tibial union point. During their treatment, our patients underwent physical treatment of the knee and ankle joints under load.

RESULTS

At the Clinic for Plastic Surgery and Burns and Clinic of Traumatology and Orthopedics, Military Medical Academy, we used free flaps and Ilizarov method in 27 wounded subjects (25 males; 2 females) with extensive tissue defects in the lower leg region in order to close their war wounds, cover deeper structures and make possible reconstruction of bone structures. The youngest patient was 18 years of age, and the oldest 58 years (32 years on the average).

Tissue defects of the lower leg were classified as Gustillo IIIB in 24 (88.88%) and Gustillo IIIC in 3 (11.11%) patients. We used free flaps and Ilizarov method in the wounded with extensive soft tissue defect and serious bone fractures and segment bone defect. Tibial defects were 4-21 cm in length (9.2 cm on the average).

According to the war surgery doctrine, we applied free flaps as primarily delayed in 11 (40.74%) or secondary in 16 (59.25%) patients. Nineteen (70.37%) miocutaneous latissimus dorsi flaps were transferred to the lower leg, 7 (25.92%)

scapular skin flaps, and 1 (3.70%) latissimus and scapular free flaps on a common vascular pedicle – subscapular artery.

Dimensions of the flaps were adjusted to the dimensions of tissue defects, and ranged from 10x15 cm skin islet of the scapular flap, up to 46x18 cm latissimus miocutaneous and skin scapular flap.

There were 27 arterial and 33 venous anastomoses during free tissue transfer, out of which 21 arterial (77.77%) and 26 venous (78.78%) «end-to-side» microanastomoses. All transferred free flaps were successful except one (3.7%) due to partial necrosis. Tibial corticotomy was done on the longer bone fragment, proximally in 20 (74.1%) and distally in 7 (25.9%) cases. Because of the invagination of flap skin between the regenerated and bone segment at the junction point during bone transport, adjunct surgical interventions were performed in 3 (11.11%) patients. Microvascular free flaps could not bear circulation disorders (injury to the vascular pedicle or flap necrosis) during bone transport. All bone transports had good regeneration; however, in 6 (22.22%) cases bone ends did not unite. Bone healing index in investigated patients was 42 days for 1 cm of bone defect.

Late complications – refracture of the union point – occurred in 2 (7.4%) patients two or three years after primary treatment. Fractures healed well with the application of PTB plaster. In 1 patient (3.7%), osteomyelitis developed, and 3 patients (11.11%) had severe contractures of the ankles and first toes. The most prominent shortening of the lower leg after treatment was 3 cm in 2 patients (7.4%). All 27 patients treated with free flaps and Ilizarov method are able to walk by themselves – without orthopedic devices.

DISCUSSION

Combination of two revolutionary methods in plastic and orthopedic surgery, free flaps and Ilizarov method, is an useful treatment option for complex tissue defects, with special significance for war wounds with extensive tissue defects of the lower leg (7). Both methods were used in the civil war in the ex-Yugoslavia, when around 2000 wounded were treated at the Clinic for Plastic Surgery and Burns and Clinic of Traumatology and Orthopedics, Military Medical Academy. Explosive devices predominated in the etiology of war wounds of the lower leg (1). Average age of the wounded (32 years) indicates that the patients belonged to a very active population group (3rd and 4th decade of life), with preserved regenerative abilities. In ex-Yugoslavia war, 63.9% of the wounded were in their 3rd decade of life (3).

According to the literature data sources (2), injury of the extremities predominate in the civil war in ex-Yugoslavia as well, which is confirmed with growing trends from the II World War (53%), Korea (53%), Vietnam (55%) war and «Desert Storm» (88.4%).

The complexity of tissue defects with bone defects (Gustillo IIIB and IIIC types) and bone defects in all patients treated with tissue transfer and Ilizarov method indicate a high degree of destructiveness of the weapons used.

In the first reparation phase of the surgical treatment of war wounds, the objectives are: closure of the defect, covering of deep structures and creation of the conditions for secondary reconstruction of deep structures. Related to the conventional plastic-reconstructive methods, the advantages of free flaps (8) were the reason why free flaps with cutaneous component – skin paddle – were used in such an early treatment phase. In the second phase, deep structure reconstruction, we utilized the Ilizarov method of bone reconstruction because of severe segmental bone loss and the osseous structure of tibia (which is not very suitable for microvascular bone reconstruction with vascularized fibula). We have made over ¾ "end to side", arterial and 26 venous microanastomoses because of the well-known advantages of "end-to-side" microanastomoses (9).

According to Ilizarov, distraction-compressive osteosyntheses and methods of distraction osteogenesis are divided into three groups based on the number of distraction/compression points; monofocal, bifocal and threefocal. We utilized monofocal, distraction-compressive method and the osseous disc was cut out and formed out of the longest bone segment (proximal tibial segment or distal tibial segment). Transplanted free microvascular flap allows for the extremity extension by Ilizarov methodology, as well as other soft tissues of the limbs, regardless of the fact that flap tissue was transferred to the lower leg from some other region of the body (10). Ilizarov method contains one new and important clinical strategy in reconstructive surgery. Percutaneous cortical osteotomy – corticotomy – is done above the healthy bone at a distance from the defect, creating thus an imtermediate fragment. Wires are used which pass through the osseous graft and are connected to the Ilizarov circulatory external fixator in order to pull the intermediate segment through the limb (1 mm a day) until it joins the target fragment. Distraction regenerate is formed between the proximal bone and transport segment. New bone fills up the place of corticotomy, eliminating bone defect. New bone matures and corticalizes fast. The patient has to use the extremity as instructed in order to stimulate regular ossification (11).

Additional surgery during bone transport is done for skin invagination between the regenerated and joining segment. After the pulling out of skin and soft tissues, we utilized long, parallel «00» nylon sutures beneath the invaginated skin and soft tissue, so that flap tissue is situated above non-resorbable sutures, and bone transport is done beneath the described sutures. We thus made the place safe, which will disable retraction while orthopedicians finish bone distraction and compression. Vocke and Schmidt describe this and other problems of the flap and soft tissue skin after their insertion into the tibial segment. They suggest prevention of retraction into the joining site by means of metal cage as space provider (12).

In our 27 cases there were no circulation problems with replaced free flaps. During the bone transport, microvascular free flap does not suffer from circulatory disorders. Because of possible circulatory disorders, ischemia of the free flaps and delayed bone transport, need for revision and exchange of pin position, Park and Lee divided the lower leg into four compartments: actively mobile, passively mobile, receptive and restrictive; the configuration of transferred free flaps and their vascular pedicles was divided into five configurations. They stressed the need for careful planning of free flap and vascular pedicle configuration in accordance with lower leg characteristics when we plan free flap and Ilizarov method in order to avoid possible complications during bone transport (13).

During the five-year follow-up period, we had re-fractures in the last 2 patients (7.4%). In 3 patients we noticed contractures of the ankle joint and toes due to massive loss of lower leg muscle tissue, 1 patient (3.7%) had osteomyelitis. Maximal leg shortening was 3 cm in 2 cases (7.4%). All 27 treated patients are able to walk by themselves – without orthopedic devices. Comparing ours with other authors' results obtained with this technique of bone replacement, our results may be classified as good, with the remark that other authors' experience relates mainly to mechanical injuries or small numbers of war wounds.

CONCLUSION

Microvascular tissue transfer provides closure of extensive defects in one act, better perfusion of the wounded region, makes conditions for the reconstruction of deep structures, especially in wounds with complex tissue defects. Ilizarov method is a useful method of bone reconstruction, especially for the lower leg. For defects longer than 4 cm, Ilizarov method provides better quality of bone replacement compared to free fibular graft. The knees and ankles are free for physical therapy in spite of Ilizarov device. In spite of the facts that the surgery is very time-consuming, that there is a need for microsurgical equipment and trained surgical team, in spite of technical complexity of the method and high proportion of unsuccessful unions of bone fragments at the joining site (which surely indicates the need for second procedure and sometimes calls for the modification of Ilizarov procedure), the combination of two revolutionary methods in plastic and orthopedic surgery, free flap and Ilizarov methods, is a useful and reliable approach to the treatment of war wounds with extensive tissue defects of the lower leg. The experience of surgeons with Ilizarov method is of utmost importance because of the long-lasting treatment and frequent check-ups of bone regeneration and sanation of the joining site.

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LEČENJE SLOŽENIH RATNIH RANA POTKOLENICE SLOBODNIM REŽNJEVIMA I ILIZAROVOM METODOM – NAŠA ISKUSTVA

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SAŽETAK

Indikacije za primenu slobodnih režnjeva i Ilizarove metode su ozbiljne frakture kostiju sa ekstenzivnim mekotkivnim defektom i segmentni koštani defekti duži od 4 cm. Tkivni defekti potkolenice su klasifikovani kao Gustillo IIIB i Gustillo IIIC. Koristili smo slobodne režnjeve i Ilizarovu metodu kod 27 ranjenih sa opsežnim tkivnim defektima potkolenice u cilju zatvaranja ratne rane, pokrivanja dubokih struktura i stvaranja preduslova za kasniju rekonstrukciju koštanih struktura. Tri meseca nakon transfera slobodnog režnja, rađena je kortikotomija i distrakcija dužeg (proksimalnog ili distalnog) koštanog segmenta tibije. Analizirali smo tip i vreme primenjenog slobodnog režnja, trajanje koštanog transporta sa Ilizarovim aparatom, kao i kvalitet rekonstruisane kosti tokom petogodišnjeg perioda opservacije. Svih 27 bolesnika koji su lečeni slobodnim režnjem i Ilizarovim metodom u mogućnosti su da sami hodaju bez ortopedskih pomagala, dok je najveće skraćenje potkolenice bilo 3 cm kod dva bolesnika (7,4%). Kombinacija dve revolucionarne metode u plastičnoj i ortopedskoj hirurgiji, slobodnog režnja i Ilizarove metode, veoma je koristan način lečenja, koji nalazi svoje mesto u lečenju ratnih rana sa ekstenzivnim tkivnim defektima potkolenice.

Ključne reči: **ratna povreda, defekt potkolenice, Ilizarova metoda**