FILLING OF TISSUE DEFECTS IN THE HAND WITH A PEDICULED OSTEOCUTANEOUS GROIN FLAP

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The aim of the study was to evaluate the efficacy of pedicled osteocutaneous groin flaps in treatment of tissue defects of the hand.  

Material and methods. Twelve pedicled osteocutaneous groin flaps were used to fill bone defects of the hand in the same amount of patients (10 males and 2 females) aged 20-53 years (mean 33.4 years, SD 12 years). The defects affected metacarpal bones and wrist in 2 cases, metacarpus alone in 3 cases, fingers – in 4 (total amputations of 3 or 4 fingers), and thumb in 3 (total amputations). The osseous fragment measured from 6-18 ccm (mean 12.4 ccm). The osteosynthesis was performed using K-wires (10 patients) or AO headless cortical screw (2 patients). The flaps were detached gradually starting from postoperative day 18 with the final detachment performed on p.o. day 24-33 (mean 27.2 days, SD 6 days). Once after flap detachment the patients maintained the limb immobilized in a plaster cast for 5 weeks. Beside local abscess which was successfully treated with compresses, healing of the surgical site was uncomplicated. The bony union was assessed radiological and occurred after 9-13 weeks (mean 11.1 weeks, SD 5 weeks). Due to delayed bone union, one patient required bone slivers grafting which finally lead to unification. All the patients needed secondary plastic surgery of subcutaneous tissue of the flap; however, only 9 of them consented to it. In three patients we substituted the sensibility with a nerve graft according to Holveich.  

Results. The described operation did not improve function in patients with wrist-level and metacarpal osseous defects but improved its esthetical aspect; in the other patients the hand function was significantly restored.  

Conclusions. In patients disqualified for other methods of reconstructions of the thumb, fingers and bone defects of the hand a satisfactory result may be achieved by using pedicled osteocutaneous flaps from the iliac crest. This method proved to be highly effective.  

Key words: hand reconstruction, bone defects, pedicled osteocutaneous flaps, groin flap

The first stage of numerous and complex reconstructions of serious hand mutilations entails restoring defects of the bony structure of the hand (1, 2, 3). In case of minor phalangeal or metacarpal defects it is common to implant devascularized bony tissue (osseous bar). However, in greater defects such an approach increases the risk of union defects or the implant absorption (4). The solution to this problem is the transfer of vascularized bony tissue as a component of a free vascularized flap or a pedicled osseocutaneous flap. The first one requires the use of microsurgical techniques and has a rate of 7 to 15% of failures (5). The latter is a pedicled osseocutaneous groin flap (GF). The operational technique of this method is relatively uncomplicated and its failure rate does not exceed 5% (6-9). Covering the superficial circumflex iliac artery, the flap was first described by McGregor and Jackson in 1972 (10). It may also include fragments of the iliac plate (from the region of the anterior superior
Filling of tissue defects in the hand with a pedicled osteocutaneous groin flap

The greatest possible dimensions of the flap, i.e. 18-35 cm, enable rolling it up with ease and thus facilitates transferring it into the hand or forearm (2, 11).

The aim of the study was to present the results of the abovementioned treatment in patients after sustained defects of soft tissues and bones within the hand.

MATERIAL AND METHODS

Over the years 2002-2008 we transferred 12 pedicled osteocutaneous groin flaps in order to restore hand bone defects in the same number of patients (10 males and 2 females) aged 20-53 years (mean 33.4 years, standard deviation 12 years). The time elapsed between the injury and the operation varied from 3 months to 6 years (mean 10 months, SD 15 months). The defects affected metacarpal bones and wrist in 2 cases (fig. 1, 2, 3), metacarpus alone in 3 cases (fig. 4 and 5), fingers – in 4, and thumb in 3 (fig. 6 – total amputations).

In case of metacarpal and wrist defects we found this method to be of choice but patients after finger and thumb amputations were offered an alternative treatment of toe transfer to which they did not consent. It is noteworthy that in this group one patient was a lower-limb amputee, and 2 patients underwent an unsuccessful 2nd toe transfer. Moreover, two patients had concomitant arterial hypertension and another two were insulin-dependent diabetics.

Fig. 1. A – a pedicled osteocutaneous groin flap transferred to the metacarpal area; due to excessive skin tension suppuration is visible within the donor site, B – the same patient: hand deformation due to tissue defects

Fig. 2. X-ray of the same patient as in fig. 1; A – metacarpal bone defect, B – postoperative view: the transferred bone graft is fixated by two crossed-over K-wires

Fig. 3. Operated hand: A – dorsal view; B – palmar view. We found the esthetical result to be excellent

Fig. 4. Posttraumatic X-ray – almost complete loss of the 2nd, 3rd and 4th ray of the hand. A – preoperative view, B – 12 months after operation: a method of osteosynthesis (two K-wires) resulted in a strong bony union

The defects were due to crush-avulsion trauma in 6 patients, circular-saw misuse injuries or amputations – 4, explosion (truck tire blast) – 1, burns – 1.

On dissecting the osteocutaneous flap covering the superficial circumflex iliac vessels
we followed the directions of McGregor and Allieu (8, 10). In 8 cases we performed an ipsilateral incision of the flap; in the rest of cases the incision was made in the contralateral groin. The width of the cutaneous part of the flap basis ranged from 10 to 14 cm, its length – from 14 to 23 cm, with the osseous fragment measuring from 6-18 cm (mean 12.4 cm).

The osteosynthesis was performed using K-wires of 1.4 to 1.6 mm in diameter set into various configurations (10 flaps) (fig. 4) or using a headless cortical screw (2 flaps). Two patients underwent a multistage reconstruction: in one of them we transferred the distal phalanx of the ring finger to a pulley which substituted for the proximal phalanx of the thumb and was created in the abovementioned method; in the other patient the transfer of the osteocutaneous flap was proceeded by an omental one covering the hand.

In three patients the flap pedicle was not rolled up due to excessive fat tissue, and thus we lined it with a skin flap. In 5 cases we performed decompressing incisions of the rolled up pedicle in order to avoid the consequences of growing edema. Two long 1/0 stitches and a bandage compress imposed a compulsory position of the limb and so prevented the tearing of the narrow union site with. In all the cases the donor site was closed primarily after wide mobilization of the adjacent tissues with a Redon drain and a fibrin sponge left in the iliac plate defect. The operation time ranged from 140 to 220 min (mean 175 min, SD 37 min).

On the attempt of detaching the flap, starting on postoperative day 18, in each case we gradually incised its pedicle (in an outpatient department) what eventually lead to its final detachment 24-33 days later (mean 27.2 days, SD 6 days). In 8 patients the operation of final flap detachment with a primary finger-substitutes plasty was carried out in local anesthesia and deep sedation. Once after flap detachment the patients maintained the limb immobilized in a plaster cast panel for 5 weeks.

This reconstructive technique required at least two hospitalizations, first of which lasted from 5 to 13 days (mean 7.2 days, SD 3 days), and the second one from 2 to 4 days (mean 3.2 days). All the patients needed secondary plastic surgery (thinning) of subcutaneous tissue of the flap; however, only 9 of them consented to it. This procedure was carried out between

**Fig. 5.** The same patient as in fig. 4 uses his hand with dexterity. A) palmar view; B) dorsal view

**Fig. 6.** An example of thumb substitution reconstructed in two steps (see the text for details); A – X-ray photo of the hand: K-wires uniting the transferred distal phalanx of the middle finger with the bony transplant taken from the iliac crest, B – example of achieved function – the patients adducts the thumb- substitute to the index finger
2\textsuperscript{nd} and 5\textsuperscript{th} month after the first operation (mean 3.9 month).

In three patients with osteoplastic thumb we substituted the sensibility with an autologous lateral sural cutaneous nerve graft in the way described by Holevich (12). In this method the available nerve branches are connected to the nerve graft which distal end is ramified under the skin; as a result neuromas are expected to grow and substitute tactile sensations.

**RESULTS**

All the flaps healed in, however, in 5 cases this process was complicated by an abscess (one of these was an insulin-dependent diabetic patient) which was successfully treated with compresses.

Bony union was achieved in 11 patients within 9 to 13 weeks (mean 11.1 weeks, SD 5 weeks); one patient underwent bone slivers grafting due to an 8-week period of non-union and finally unification was achieved after 18 weeks. Final both functional and esthetical results were evaluated after 11-15 months (mean 13.2 months, SD 3 months). One patient failed to turn up for the follow-up. The described operation did not improve function in patients with wrist-level osseous defects; the other patients resulted capable of performing activities they had been unable to do or found them much easier to perform after the operation (using the cutlery, teeth brushing, writing etc.).

The postoperative esthetical results after wrist-level bone defects restitution was assessed as excellent, after digital substitutes formation as satisfactory, and after thumb substitutes as good. Both the patients after sensibility substitution were able to feel however hard to describe but distinct tactile sensations.

**DISCUSSION**

Pedicled flaps pertain to the oldest reconstructive techniques. This method is limited by the necessity of keeping the flap’s base width to its length ratio which is 1:2 for the trunk (13). It is possible to cover a greater area by using arterialized flaps, i.e. fed by an axial arterial vessel along which the flap is dissected. The pedicled osteocutaneous groin flap (GF) exemplifies well this technique (10). Originally, the GF is based on the superficial circumflex iliac artery (SCIA). Tylor reasoned it would be safer to base the GF on the deep circumflex iliac artery (DCIA) which like the SCIA braches from the femoral artery; however, greater area supplied by the SCIA and harder dissection of DCIA argue in favor of the original approach (11).

Bony fragment of the anterior superior iliac spine harvested together with soft tissues has the periosteum intact with its nourishing vessels; as a result the graft forms full-value osseous tissue which process of healing in does not differ from that of a common fracture (15). Reinisch confirmed this observation basing on the biopsy specimen and fluorochromatic studies (16). Maximal dimensions of iliac plate fragment of the GF which can be transferred without jeopardizing its blood supply are 4×3×8 cm (2, 17). Over the 30 years that passed since the original description of the GF there were many modifications of this method proposed by numerous authors. Ackland proved it possible to extend the GF area towards lateral direction as well as transferred the GF with a bony fragment of the iliac plate, that is the iliac flap was transferred as a free graft (18).

Tissue defects (including the osseous ones) of the hand and forearm do not call for the use of free grafts since this problem is successfully solved with the pedicled GF. The unease period of a 3-week immobilization of the limb close to the abdominal wall is relatively well tolerated by the patients.

The presented material discusses three groups of patients (bone defects of the hand, fingers and thumb amputations) who represent different types of indications for the operation. Restitution of major osseous defects of the wrist and metacarpus with this method seems to be the treatment of choice.

Sometimes grafting an devascularized bone does not guarantee it proper healing (4), while a free vascularized flap seems a “waste of energy and means”.

The lack of the thumb and/or fingers necessitates a different type of operational solution which would guarantee possibly greatest range of the restored grip function. According to the rule formulated by Etkin, the hand function bases on the ability to oppose the thumb against the ulnar column of the fingers (19). If a patient does not give his/her consent or the-
there is no technical viability for toe transfer the formation of a stable opposing element – even one lacking sensibility – improves satisfactorily the function of the fingerless, so called metacarpal, hand (20, 21).

Digital reconstructions with pipe-shaped flaps harvested with a bony fragment (pedicled grafts from the iliac plate, rib, clavicle or the radial island flap) are called osteoplastic reconstructions (22, 23). Majority of reports available in medical databases describe applying this method of thumb reconstruction in few patients only (7, 8, 17). The end result is acceptable both functionally and esthetically according to most authors.

Basing on his own material of 17 patients, Bielecki compared the results of thumb reconstruction using the “classical” methods (such as thumb elongation, pollicisation and osteoplasty) against microsurgery. The authors assessed the results achieved with osteoplasty in 4 patients as good (24). Parmaksizoglu presented good results achieved in 3 patients and stressed the high efficiency of this operational approach (25). It should be emphasized that the patients described by both the authors had their thumbs amputated at the MCP joint and the presence of intact fingers made it possible to form easily a sensory island. Molski presented 9 flaps which served for the reconstruction of the first ray of the hand (8 flaps) and the middle phalanx of the ring finger (1 flap). In all of the cases the author achieved appropriate flap healing although the process was complicated by local inflammation in as much as 75% of cases (26).

The reason for which we included only 3 patients in our study of thumb reconstruction with the use of osteoplastic methods is because we think that, contrary to other indications presented in the paper, this method of thumb reconstruction should be reserved to a carefully limited group of patients (27). An approach which seems more promising is a combined thumb reconstruction with the use of osseous flap and pollicisation. Implemented in one patient, this method made it possible to form a basal phalanx onto which was transferred a distal phalanx of an immobilized ring finger (fig. 6). As a result the patient obtained a thumb substitute with a full sensory range in the distal phalanx with a much more favorable esthetical aspect.

CONCLUSIONS

1. The restitution method of osseous defects of the hand with the use of osteocutaneous flaps harvested from the iliac crest is characterized by high efficacy.

2. This operational approach of forming digital substitutes which constitute an opposable element against the functional thumb allow for a significant improvement of the hand function.

REFERENCES

COMMENTARY

In 1980's groin flap presented by McGregor and Jackson in 1972 was a modern modality for resurfacing large hand defects. Introduction of microsurgical techniques to the surgical management largely limited indications for the use of the above mentioned flap.

Success rate of microsurgical reconstruction that allows for the transfer of complex free tissue flaps, exceeds 95% in good sites that use microsurgical technique; this is the routine management in this indication.

Currently reconstructive management starts with this type of reconstruction and alternative technique (i.e. pedicled flaps) is used only when complex tissue flaps may not be used.

Use of tissue flaps on free and pedicled perforators in the reconstructive treatment that allows for sparing of large blood vessels being important for perfusion of the reconstructed region and consequently its functionality, starts to be a first line management strategy in microsurgical sites.

Optimally, patients with injuries requiring complex reconstructions should be referred to microsurgical sites that use up to date treatment methods.

In view of these facts the statements by the authors of the paper: “the discussed reconstruction of large skeletal defects in the wrist and metacarpus area seems to be the management of choice” and “free, vascularized graft seems to be effort and resource wasting strategy” is not only controversial but cannot simply be accepted. These opinions of the authors of the paper are based on literature data from 1990's and earlier reports, which is not an advantage of presented bibliography; this applies to bibliography on microsurgical techniques in particular.

In conclusion, surgical management using a groin flap presented by the Authors, may be efficiently used by any department of surgery and orthopedics. However free tissue flaps that lead to shortening of treatment time, cost reduction and at least the same functional effects, are the first line strategy in microsurgical sites.

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