

# A CLINICAL STUDY OF THE EXTENDED LATERAL ARM FLAP

RENATO RIBEIRO GONÇALVES, ÁLVARO BAIK CHO, FABIANO INÁCIO DE SOUZA,  
MARCELO ROSA DE REZENDE, LUCIANO RUIZ TORRES, RAMES MATTAR JUNIOR, ARNALDO VALDIR ZUMIOTTI

## ABSTRACT

**Objective:** To prospectively evaluate the results obtained in the treatment of patients with cutaneous lesions smaller or equal to 20cm long by 10cm wide with the use of lateral arm flap extended distally to the lateral epicondyle of the elbow. **Methods:** 23 patients underwent surgery, 69.5% of them male, 73.9% of traumatic origin, and the receiving region was the lower limb in 65.2% of cases. The age ranged from 6 to 62 years, with an average of 32 years. Minimum follow-up care was 5 months. **Results:** We succeeded in 100% of cases. The size of flaps ranged from 9 to

20 cm in length, with an average of 14cm, and width, from 3 to 8cm, with an average of 5.5cm. The greatest distance between the lateral epicondyle and the distal flap was 8cm, ranging from 2cm to 8cm, with an average of 4.9cm. **Conclusion:** The lateral arm flap, extended distally to the lateral epicondyle of the elbow, was safe to cover cutaneous lesions of size equal to or smaller than 20cm long by 10cm wide, with the extension of the flap up to 8cm distal to the lateral epicondyle.

**Keywords:** Clinical Trial. Anatomy. Surgical flaps.

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## INTRODUCTION

The performance of the first microsurgical flap in the free axial form, in the 70s, opened a new perspective in the treatment of the cutaneous cover of complex limb lesions.<sup>1</sup> This method enables the use of flaps that have their own vascularization, independent from the receptor bed. Its formal indication consists of extensive lesions with loss of substance, exposure of bone, tendon and/or vasculo-nerve structures, as well as in regions where the receptor bed is poorly vascularized. In these situations treatments with simple procedures such as primary suture, skin grafting or healing by second intention, are contraindicated.

The flap from the lateral region of the arm is one of the most well studied in literature.<sup>2</sup> It is a flap of the septocutaneous type, located in the posterolateral area of the arm, between the deltoid insertion and the humerus lateral epicondyle, with dimensions of 12cm of length by up to 10cm of width.<sup>3</sup> The pedicle is based on the posterior radial collateral artery, a branch of the profound brachial artery, which exhibits constant anatomy.<sup>4</sup> This flap can be dissected distally to the lateral epicondyle, on the lateral side of the elbow and proximal forearm, which would enable the duplication of the pedicle length in comparison with

the conventional form.<sup>5</sup> However, there are few clinical studies employing this method.

To prospectively evaluate the results obtained in the treatment of patients with cutaneous lesions smaller or equal to 20 cm long by 10 cm wide using the lateral arm flap extended distally to the lateral epicondyle of the elbow.

## MATERIALS AND METHODS

The study performed was an open prospective clinical trial, comprised of 23 patients, coming from the Hand and Microsurgery Group of the Orthopedics Institute of Faculdade de Medicina da Universidade de São Paulo. All the patients were evaluated by the same group of micro-surgeons, following a pre-established protocol.

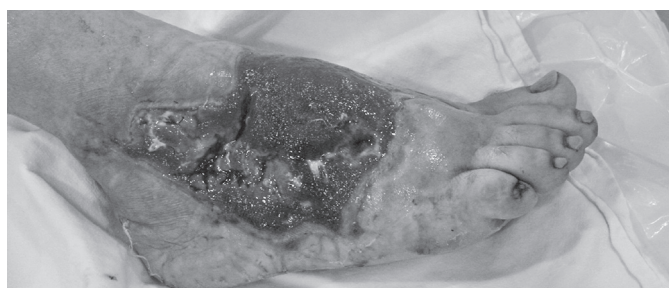
The inclusion criteria of the receptor region were cutaneous lesions with loss of substance and exposure of prime structures (arteries, veins, nerves, tendons, cartilage and/or bone structures), of dimensions equal to or smaller than 20 cm long by 10cm wide. (Figures 1 and 2) Patients with any kind of change in the skin (congenital deformities, burns, scars, wounds), of the lateral region of the arm and of the forearm of the donor area, *diabetes mellitus* and peripheral vascular disease were excluded.

All the authors declare that there is no potential conflict of interest referring to this article.

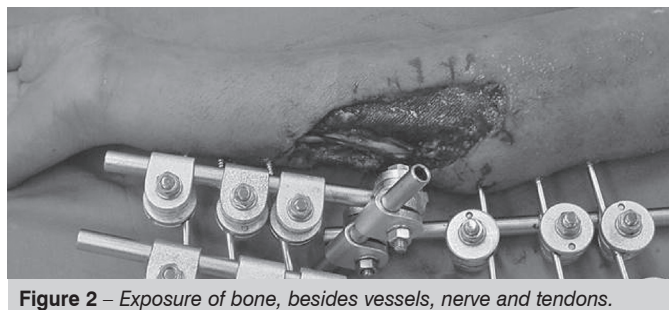
Laboratory for Medical Investigation of the Musculoskeletal System – LIM 41 of the Department of Orthopedic and Traumatology

Study conducted at the Institute of Orthopedics and Traumatology of Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo.  
Mailing Address: Rua Dr Ovídio Pires de Campos, 333, 8º andar, Cerqueira César, São Paulo-SP Cep:05403000. Email: [renatoribgon@uol.com.br](mailto:renatoribgon@uol.com.br).

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**Figure 1** – Cutaneous lesion exposing bone tissue and joint.



**Figure 2** – Exposure of bone, besides vessels, nerve and tendons.

Sixteen male patients and 7 female patients were operated. Age varied from 6 years to 64 years, with mean age of 32 years. As regards the etiology of the origin of the cutaneous lesion, 17 patients had trauma as primary etiology and 6 patients presented complications in the closing of the surgical wound. (Table 1) The flap receptor region was on the upper limb in eight cases and on the lower limb in 15 cases.

The preoperative evolution time was defined between the start of the skin lesion and the day the microsurgical flap was fashioned. Minimum follow-up time was 5 months, after the performance of the flap.

The investigators collected the individual anthropometric data, containing the arm length measurement (distance between the anterior region of the acromion and the lateral epicondyle of the humerus), the forearm length measurement (distance between the lateral epicondyle of the humerus and the ulnar styloid process), the arm perimeter measurement (measured 9cm overlying the lateral epicondyle), the forearm perimeter measurement (measured 5cm distally to the olecranon), besides the weight and height of each patient.

When there was bone impairment, radiographies were taken of the front and sides of the limb affected by the lesion, with an arteriography in cases with suspicion of arterial impairment.

All the patients from this study completed a term of free and clarified consent from Hospital das Clinicas da Faculdade de Medicina da Universidade de São Paulo.

## SURGICAL TECHNIQUE

The patients were positioned in supine, with the arm abducted at 90 degrees and the elbow in slight flexion, on the operating table. Prophylactic antibiotic therapy was performed with the anesthetic induction, with trichotomy, anesthesia with plexus block and/or general anesthesia and use of pneumatic tourniquet placed on the proximal third of the arm.

The flap was delimited in the distal third of the lateral aspect of the arm, and extended distally to the lateral epicondyle. (Figure 3) The flap axis and the proximal incision necessary to dissect the pedicle are drawn along the line between the deltoid muscle insertion proximally and the lateral epicondyle distally. The incision in the deep fascia was made in alignment with the skin. The posterior half of the flap was released from the underlying triceps muscle, until the septum was exposed. It separates the anterior and posterior compartments of the arm and contains the vasculo-nervous plexus with the posterior radial collateral artery, which is the supplying artery of the flap. The same dissection was executed in the anterior part of the flap to release it from the underlying muscles, which are the brachial, the brachioradialis

**Table 1** –List of patients of this study.

| N  | Sex | Age | Lesion site                          | Lesion etiology                     | Lesion / surgery time | Lesion dimensions in cm (length x width) |
|----|-----|-----|--------------------------------------|-------------------------------------|-----------------------|--|
| 1  | M   | 55  | Instep of right foot                 | Car accident                        | 2 months              | 18 cm x 8cm                              |
| 2  | F   | 22  | Right calcaneal tendon               | Tendon lengthening surgery          | 4 months              | 12 cm x 4 cm                             |
| 3  | M   | 48  | Left forearm diaphysis               | Wound with large knife              | 2 months              | 12 cm x 6 cm                             |
| 4  | M   | 31  | Back of ankle and right foot         | Sequela of exposed fracture         | 5 years               | 14 cm x 6 cm                             |
| 5  | M   | 32  | Back of ankle and left foot          | Sequela of exposed fracture         | 15 days               | 20 cm x 6 cm                             |
| 6  | M   | 20  | Right ventral forearm                | Motorcycle accident                 | 20 days               | 20 cm x 6 cm                             |
| 7  | F   | 62  | Lateral malleolus of right ankle     | Sequela of ankle osteosynthesis     | 1 year                | 13 cm x 4 cm                             |
| 8  | M   | 17  | Left cubital fossa                   | Scleroderma                         | 5 years               | 13 cm x 5 cm                             |
| 9  | M   | 51  | Left wrist and hand                  | Cut with saw                        | 2 years               | 14 cm x 6 cm                             |
| 10 | M   | 06  | Right forearm                        | Electrical burn                     | 2 days                | 10 cm x 5 cm                             |
| 11 | F   | 17  | Left foot                            | Dehiscence of surgery wound on foot | 4 months              | 10 cm x 4 cm                             |
| 12 | M   | 42  | Right calcaneal tendon               | Tendon lengthening surgery          | 5 months              | 9 cm x 4 cm                              |
| 13 | F   | 36  | Right wrist                          | Sequela of exposed fracture         | 10 months             | 11 cm x 6 cm                             |
| 14 | M   | 25  | Right calcaneal tendon               | Tendon lengthening surgery          | 1 year                | 8 cm x 4 cm                              |
| 15 | M   | 07  | Right wrist and hand                 | Machine at bakery                   | 5 days                | 13 cm x 7 cm                             |
| 16 | F   | 40  | Instep of left foot                  | Sequela of exposed fracture         | 25 days               | 11 cm x 6 cm                             |
| 17 | M   | 30  | Left lateral malleolus               | Sequela of exposed fracture         | 6 months              | 20 cm x 5 cm                             |
| 18 | F   | 35  | Right foot                           | Sequela of ankle fracture           | 3 months              | 17 cm x 7 cm                             |
| 19 | M   | 15  | Right foot                           | Run-over                            | 15 days               | 9 cm x 4 cm                              |
| 20 | M   | 29  | Ventral side/aspect of right forearm | Sequela of exposed fracture         | 15 days               | 16 cm x 7 cm                             |
| 21 | F   | 9   | Instep of right foot                 | Sequela of exposed fracture         | 15 days               | 13 cm x 7                                |
| 22 | M   | 64  | Right lateral malleolus              | Chronic osteomyelitis               | 1 year                | 9 cm x 4 cm                              |
| 23 | M   | 33  | Lateral side/aspect of right foot    | Chronic osteomyelitis               | 2 years               | 8 cm x 4 cm                              |

Source: IOT-HCFMUSP

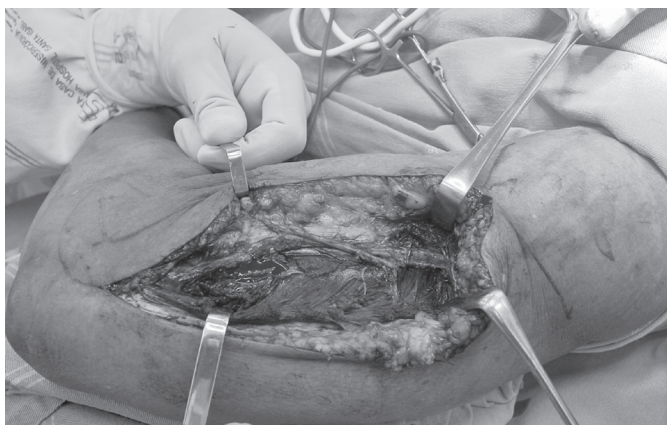


**Figure 3** – Planning of the flap design.

and the extensors. One then arrives at the proximal incision and identifies the plane between the deltoid and triceps muscles. The deltoid and triceps muscles are retracted, to expose the vascular pedicle of the flap and the radial nerve. The deep artery of arm and its two veins are carefully isolated from the nerve. The anterior radial collateral artery is connected and divided. Both nerves, lateral cutaneous nerve of arm and posterior cutaneous nerve of forearm, are identified. An incision is then performed in the septum close to the bone, to release the flap. (Figure 4)

The surgical dissection of the receptor area was performed simultaneously by another surgical team. The artery was always anastomosed by means of a termino-lateral suture and the veins by termino-terminal suture. The turgor, temperature, coloration and viability of the flap were observed in the immediate postoperative period (up to 48 hours). After this period, it was evaluated whether there was presence of flap necrosis or not. In the cases that presented necrosis, they would be graded as epidermolysis, partial necrosis and total necrosis (loss of the flap). In the donor region it was analyzed whether there was primary closing of the skin or not, and in the late postoperative period they measured the articular amplitude of the elbow.

The descriptive statistics were used for presentation of the ordinal (quantitative) values: mean, standard deviation, minimum, maximum and total number (n).



**Figure 4** – Identification of the pedicle.

## RESULTS

The survival of the flap was obtained in all cases. The dimensions of the flaps ranged from 9 to 20 cm in length, with a mean value of 14cm (Figure 5), and from 3 to 8 cm in width, with a mean value of 5.5cm. The greatest distance between the lateral epicondyle and the distal extremity of the flap was 8 cm, ranging from



**Figure 5** – Detail of the microsurgical flap.

2cm to 8cm, with mean value of 4.9cm. In all the cases there was no impairment of the range of motion or of the muscular force of the donor limb. The cosmetic result was also satisfactory. (Figure 6 and 7)



**Figure 6** – Immediate postoperative period.



**Figure 7** – Detail of the donor region.

## DISCUSSION

In recent decades there has been a considerable increase of the use of microsurgical techniques, making this indication more and more frequent. However, it proved necessary to discover new donor regions to fulfill the treatment needs of the different kinds of cutaneous lesions.<sup>6</sup> This need stimulated several investigators to conduct studies in pursuit of the ideal flap, which would present constant vascular anatomy, executable in several formats, with minimum morbidity for the donor area, with sufficiently long vascular pedicle and with vessels of compatible diameter with microanastomoses.<sup>7,8</sup>

Among the septocutaneous flaps, special emphasis is placed on the lateral arm flap, described by Song et al.<sup>2</sup>, which presents variable dimensions (conventional, extended distally to the lateral epicondyle), different formats (like an island, with presence of bone tissue, nerves, tendon and muscular tissue),



possibility of primary closing of the donor region, positioning of the patient in supine and low morbidity.<sup>9,10</sup> These peculiarities make this flap one of the best options of cutaneous coverage in several clinical situations.

In our casuistry, we observed 69.5% of the cases of the male sex, a finding similar to that encountered by Harpf et al.<sup>11</sup>, with lesions of traumatic etiology composing the majority of cases (73.9%). Lister and Scheker<sup>6</sup> affirm that this flap is the best option for cutaneous coverage of the hand. We agree and emphasize the excellent results for the lower limbs as well.

Minimum follow-up time was 5 months, sufficient for stabilization of the soft parts.<sup>12</sup>

The indications for choice of the lateral arm flap extended distally to the lateral epicondyle, were: exposure of prime structures (arteries, nerves, tendons and/or bone structures) and the cutaneous lesion area being shorter than 20 cm, with width below 10 cm. The area defined for this study was established by previous anatomical and clinical studies.<sup>13,14</sup>

The choice of the fusiform format of the flap aimed to facilitate the closing of the donor region. In situations where the design of the receptor region is not fusiform, it is possible to remodel the flap before its implantation in the receptor area.<sup>15</sup>

Since the needs of the cases studied are only for cutaneous coverage, all the flaps were only of the septocutaneous form. Because of the characteristics of its local irrigation, besides the septocutaneous form, the lateral arm flap could also have been made in a composite manner, including part of the triceps muscle, lateral portion of the distal humerus, sensitive branches of posterior cutaneous nerve of arm or inclusion of the posterior cutaneous nerve of forearm.<sup>7,9,16</sup>

This type of study was restricted to evaluating the dimensions and the survival of the flap, regardless of the functional result obtained in the receptor area, as the cases are heterogeneous in the etiology, in time between the lesion and the cover and particularly in the diversity of associated lesions. The evaluation of the flap's efficiency, as viable and non-viable, is employed by several authors.<sup>8,17,18</sup>

The survival of the flaps occurred in 100% of the cases, which represents the reliability of the treatment option with microsurgical flap. These results are similar to those reported by other authors.<sup>17,19</sup>

The dimensions encountered in this study varied in length, from 9cm to 20cm, with mean length of 14cm, and in width, from 3 cm to 8 cm, with mean width of 5.5cm. Handi and Coessens describe variation of length, from 8cm to 23cm, with mean length of 13cm and of width, from 5 cm to 8cm, with mean width of 6cm,<sup>8</sup> Haas et al.<sup>20</sup> encountered variation of length, from 9cm to 15cm, with mean length of 11.5cm, and in width, from 4.5cm to 8cm, with mean width of 6 cm.

No functional losses were found in any of the cases that were relevant to the donor region, such as decrease of force and of the range of motion of the elbow and forearm, characterizing a flap of low morbidity. The greatest possibility of complication is in the performance of vascular microanastomosis.

## CONCLUSION

The lateral arm flap extended distally to the lateral epicondyle of the elbow proved safe and effective for the cutaneous cover of lesions measuring 20cm in length by 10cm in width or smaller, with prolongation of the flap up to 8cm distal to the lateral epicondyle.

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