

VOLUME 113 • NUMBER 2 • FEBRUARY 2004



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Journal of the American Society of Plastic Surgeons

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Design of the Limberg Flap by a Specially Designed Ruler: A Personal Approach

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The Limberg flap requires a rhomboid defect with all sides equal and set in position at angles of 60 degrees (against the longer axis) and 120 degrees (against the shorter axis) (Fig. 1).¹⁻³

The Limberg flap (*CDEF*) consists of the defect margin, the side (*DE*) presenting extension of the short width of the defect, the side (*EF*) turned at an angle of 60 degrees related to the side (*DE*), which is parallel to the defect side (*DC*) (Fig. 1).^{1,4-7}

There are single, double, and triple Limberg flaps for rhomboid defects.¹⁻⁶ Single flaps have four potential combinations, double flaps have five combinations, and triple flaps for closure of circular or hexagonal defects have two combinations.⁵⁻⁸ The creator of this flap, Alexander Limberg, offered detailed instructions on its usage with precisely defined rules for its molding more than 50 years ago.³

In surgical practice, however, despite very clear rules for molding this flap, its design is very difficult in terms of molding of equal margins and precise angles of 60 and 120 degrees. The molding of a flap with unequal margins and unequal angles is very common.

MATERIALS AND METHODS

Considering this problem, we devised seven special rulers for planning and designing the Limberg flap for closure of rhomboid and hexagonal defects. On the first ruler, there are impressed rhomboids with side lengths of 0.5 cm (the diameter of the circle that would fit into it is $R = 0.25$ cm), 0.75 cm ($R = 0.35$ cm), 1.0 cm ($R = 0.45$ cm), 1.25 cm ($R = 0.55$ cm),

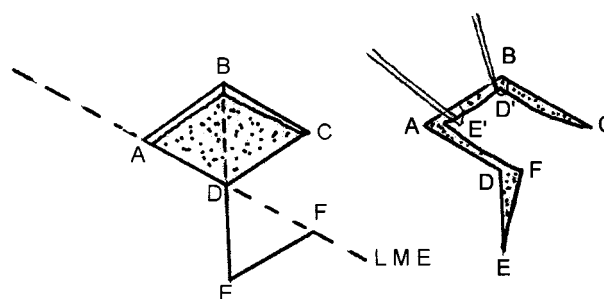


FIG. 1. Design of the Limberg flap. The Limberg flap (*CDEF*) consists of the defect margin, the side (*DE*) presenting extension of the short width of the defect, the side (*EF*) turned at an angle of 60 degrees related to the side (*DE*), which is parallel to the defect side (*DC*).

1.5 cm ($R = 0.65$ cm), and 1.75 cm ($R = 0.75$ cm). On the second ruler, there are impressed rhomboids with side lengths of 2.0 cm ($R = 0.9$ cm), 2.5 cm ($R = 1.1$ cm), 3.0 cm ($R = 1.3$ cm), 3.5 cm ($R = 1.3$ cm), and 4.0 cm ($R = 1.7$ cm). On the third ruler, there are impressed rhomboids with side lengths of 5.0 cm ($R = 2.1$ cm), 6.0 cm ($R = 2.6$ cm), and 7.0 cm ($R = 3.0$ cm) (Fig. 2). With the fourth, universal ruler, we can design Limberg flaps of any length and combination (Fig. 3).

On the fifth ruler, there are impressed hexagons with side lengths of 0.5 cm (diameter of the circle that would fit into it is $R = 0.9$ cm), 0.75 cm ($R = 1.3$ cm), 1.0 cm ($R = 1.7$ cm), 1.25 cm ($R = 2.2$ cm), 1.5 cm ($R = 2.6$ cm), and 1.75 cm ($R = 3.0$ cm). On the sixth ruler, there are impressed hexagons with side lengths of 2.0 cm ($R = 3.5$ cm), 2.5 cm ($R = 4.3$ cm), and 3.0 cm ($R = 5.2$ cm). And

From the Department of Plastic and Reconstructive Surgery, Belgrade University School of Medicine, and the Institute for Burns, Department of Plastic and Reconstructive Surgery, Clinical Center of Serbia. Received for publication January 15, 2003.

DOI: 10.1097/01.PRS.0000101534.00262.C6

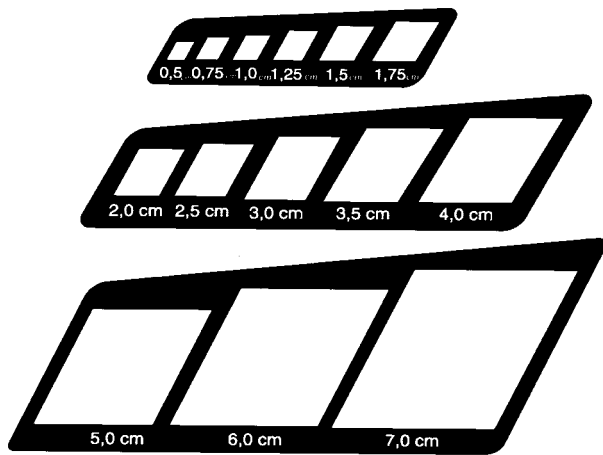


FIG. 2. Rulers with impressed rhomboids of various sizes for Limberg flap design.

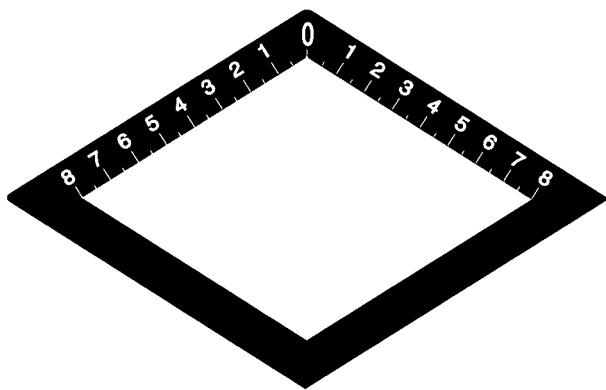


FIG. 3. A universal ruler for design of the Limberg flap of various sizes and combinations.

on the seventh ruler, there are impressed hexagons with side lengths of 3.5 cm ($R = 6.0$ cm) and 4.0 cm ($R = 7.0$ cm). These three last rulers are used for closure of circular (i.e., hexagonal) defects (Fig. 4).

The rulers are made of two materials: metal and transparent, heat-resistant plastic.

Flap Design

First, the size of the defect is defined, and the lines of maximum extensibility as well as relaxed skin tension lines are oriented. Flap design starts so that a ruler with a definite template (of appropriate size) is placed in the location of pathologic changes. Taking into account the lines of maximum extension,⁹ rhomboid contour is marked by a pencil, and the ruler is rotated through 60 degrees; thus, the site for flap design is obtained automatically (Fig. 5).

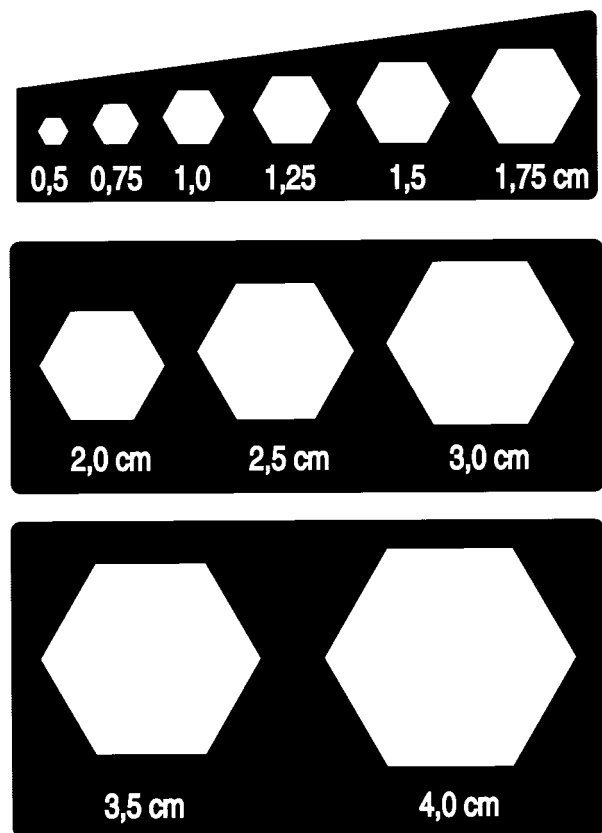


FIG. 4. Rulers for closure of circular (i.e., hexagonal) defects.

When we wish to apply a triple Limberg flap, we use a ruler with hexagons for marking the pathologic changes (Fig. 6). Then, we take a ruler with rhomboids with sides equal in length to the sides of the hexagon and design three Limberg flaps (Fig. 6).

Using our rulers, we have also designed the four-part Limberg flap,⁸ which requires great precision. We achieved this four-part flap easily, securely, quickly, and successfully with our rulers. We call this method of reconstruction “mini flaps for maxi defect” (Fig. 7).

DISCUSSION

The Limberg flap has great applications in plastic and reconstructive surgery. The Limberg flap design requires precision and careful positioning in a rhomboid defect and depends directly on the power that performs tension on a flap related to localization of the skin lines of maximum extensibility.^{1,5,7}

Our technique for designing the Limberg

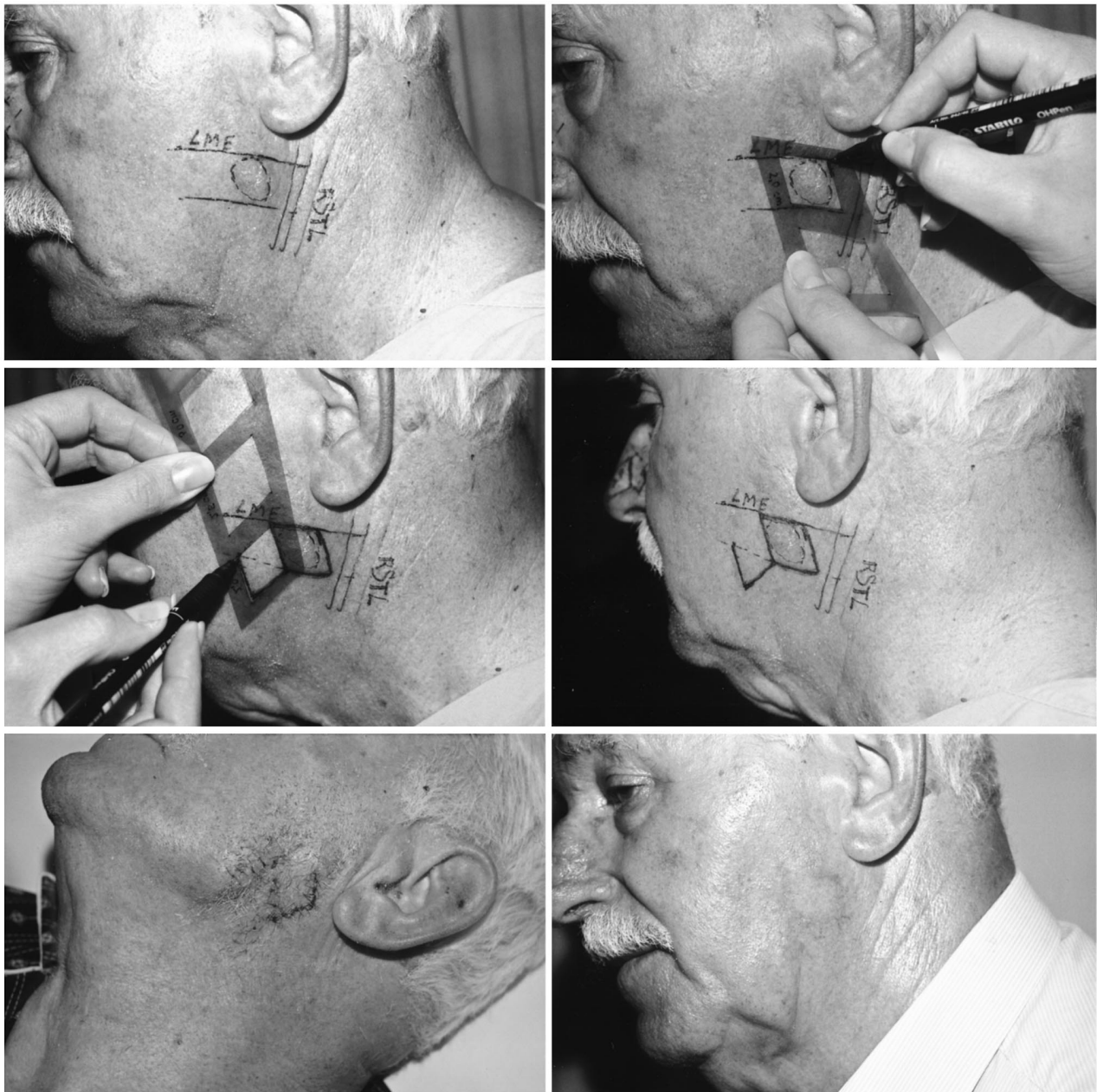


FIG. 5. (Above, left) Defining the size of the changes and orientation of the lines of maximum extension (LME) as well as the relaxed skin tension lines (RSTL). (Above, right) Setting the ruler in the location of pathologic changes by orienting the ruler related to the lines of maximum extension. (Center, left) Rotation of the ruler and designing the location of the Limberg flap. (Center, right) Designed Limberg flap. (Below, left) The result 5 days later. (Below, right) The result 14 days later.

flap considerably simplifies and reduces time of the traditional flap-designing technique; its very fast orientation is related to the lines of maximum extension with precision of 100 percent. Using our rulers, we need only 15 minutes for defect reconstruction using triple or four-part Limberg flaps.⁸ Plastic rulers offer greater possibilities than metal ones because of their flexibility, which permits flexion over uneven contours such as the face and nose. Fur-

thermore, the transparency of plastic enables better visualization of skin changes during flap design. The advantage of metal rulers is their ability to be sterilized even in a dry-heat sterilizer. Our rulers are better related to some templates¹⁰ because rhomboids of every size can be designed, and the rulers have hollow impressed rhomboids; thus, they can be placed even over tumorous changes that are above skin level (Fig. 6).

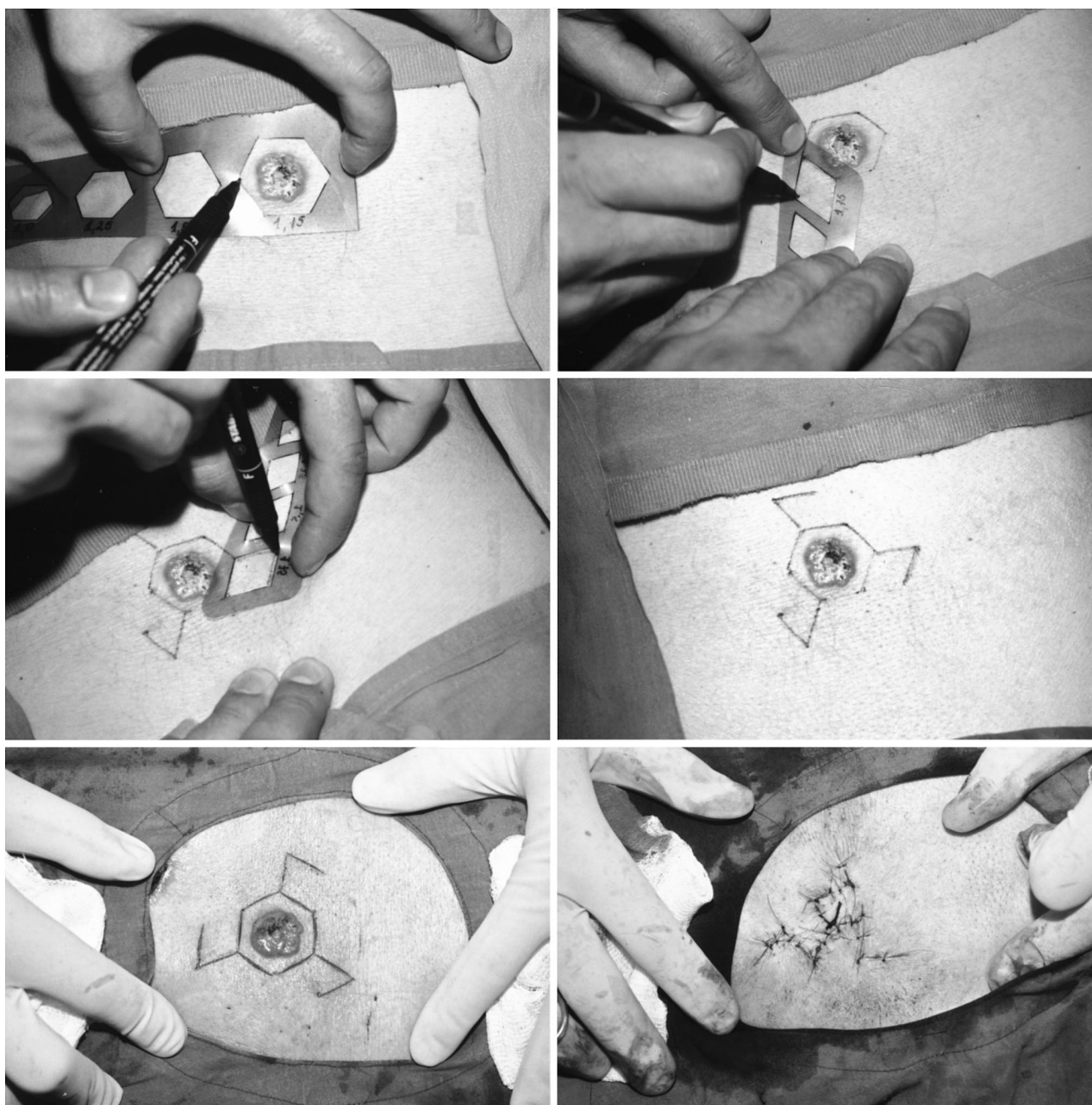


FIG. 6. (Above, left) Setting the hexagon ruler and designing the hexagonal defect. (Above, right) Limberg flap designed using ruler with impressed rhomboids, with the sides equal to the sides of a hexagon. (Center, left) Design of Limberg flaps to close hexagonal defects. (Center, right) Designed triple Limberg flap. (Below, left) Contours of previously designed triple Limberg flap marked with the scalpel. (Below, right) Reconstructed hexagonal defect using triple Limberg flap.

SUMMARY

Though the theoretical design and construction of the Limberg flap are very clear, practically, there are some difficulties in designing sides of equal length and forming precise angles of 60 and 120 degrees; therefore, flaps with unequal sides and unequal angles are very frequent. We devised special ruler templates

for Limberg flap design and demonstrated their use in planning and reconstructing rhomboid defects and their combinations.

The technique for designing the Limberg flap, using our ruler templates, is considerably simplified, allowing for fast reconstruction of rhomboid and hexagonal defects with 100 percent precision. The ruler can also be

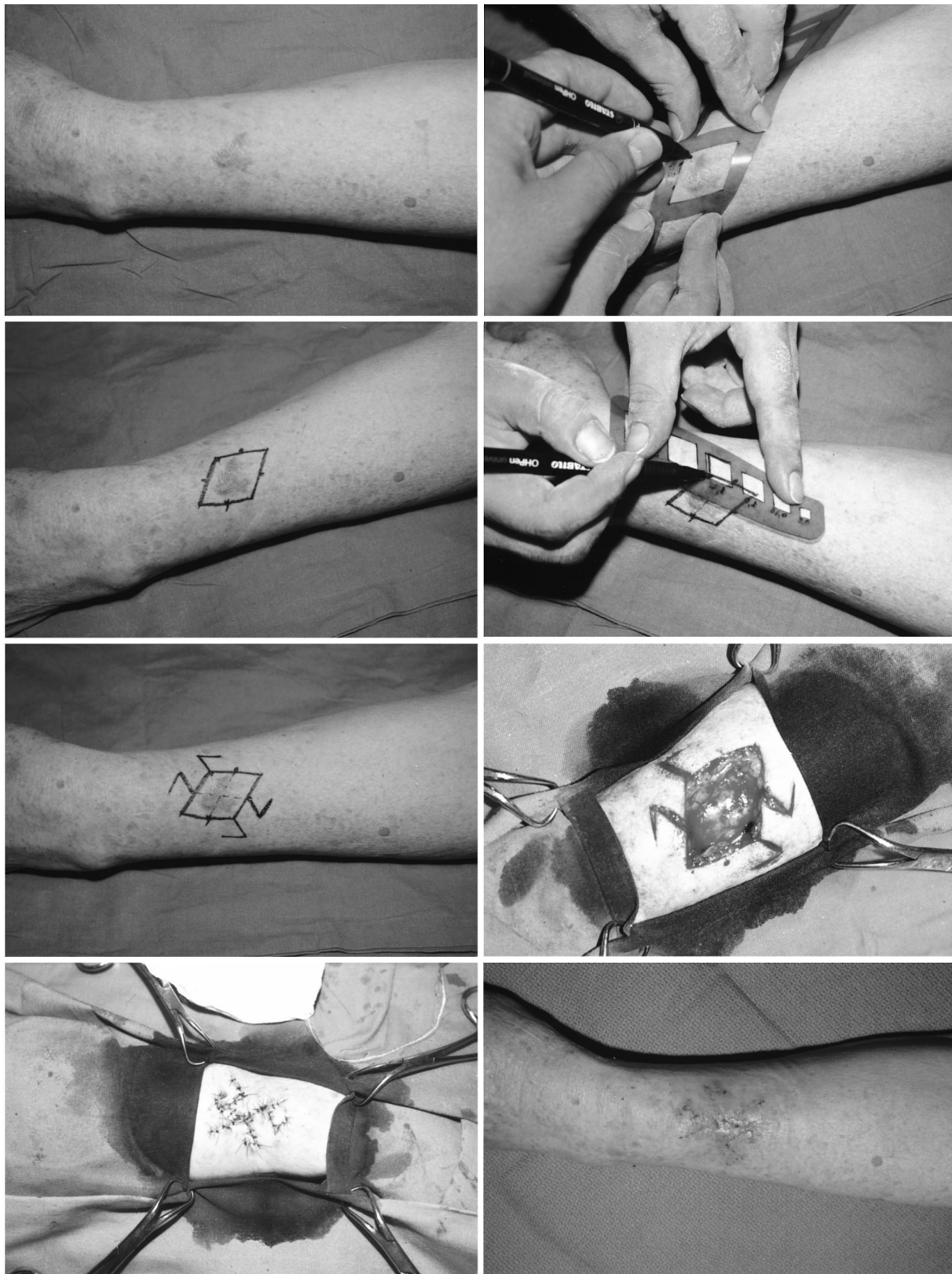


FIG. 7. Reconstruction of rhomboid defect using the four-part Limberg flap ("mini flaps for maxi defect"). (*Above, left*) Basal cell carcinoma in the region of the distal part of the forearm. (*Above, right*) Rhomboid design using rulers. (*Second row, left*) Designed future rhomboid defect that cannot be closed by a single Limberg flap. (*Second row, right*) Design of mini-rhomboid flaps. (*Third row, left*) Designed mini-rhomboid flaps. (*Third row, right*) "Mini" rhomboid flaps for "maxi" defect. (*Below, left*) Closed defect. (*Below, right*) The result 2 weeks later.

used for education and training in skin flap surgery.

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