

# Morphometric Evaluation of Liver, Spleen, and Kidney Wounds Cleansing from Necrosis after Wound Suturing by Different Methods: An Experimental Study

O. V. Musatov, S. A. Zurnadjan, and O. Ye. Bogatryyova\*

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Morphometrical evaluation of cleansing from necrosis was carried out 1-360 days after plastic repair of lacerated and contusion wounds of the liver, spleen, and kidney in rabbits by serous/muscular flaps from the greater curvature of the stomach on a vascular pedicle. This method of suturing led to 12-fold more rapid cleansing of liver wounds from necrosis in comparison with hepatorrhaphy, 13-fold more rapid cleansing of splenic wounds in comparison with omentolienoplasty, and 3-fold more rapid cleansing of renal wounds in comparison with omentonephroplasty.

**Key Words:** *morphometry; liver; spleen; kidney; stomach*

Ruptures of the liver, spleen, and kidneys are common results of closed abdominal injuries. The rate of wound healing and course of its regeneration largely depend on the rate of wound cleansing from necrotic elements.

We evaluated the morphology and function of the liver, spleen, and kidney wounds after their plastic repair with a serous/muscular gastric flap and the greater omentum.

## MATERIALS AND METHODS

The study was carried out on 78 Chinchilla rabbits (1.5-2.0 kg; 6-12 months). In experimental group ( $n=39$ ), a serous/muscular flap including the right gastroepiploic artery was cut from the greater curvature of the stomach (SMFS). Donor wound on the stomach was sutured. In the same animals lacerated contusion wounds were modeled on the anterior surface of the liver ( $n=13$ ), lower pole of the spleen ( $n=13$ ), and outer edge of the left kidney ( $n=13$ ).

The wounds were covered with SMFS and fixed by a double twisted suture on the liver and kidney [2] and by U-shaped sutures on the spleen. In controls, double twisted suture was used for hepatorrhaphy ( $n=13$ ) and for fixation of the greater omentum to the wound in the left kidney ( $n=13$ ); omentopexy to repair the spleen wound ( $n=13$ ) was carried out using perforating U-shaped sutures. The animals were sacrificed by intrapleural thiopental on days 1-360 of the experiment with consideration for "Regulations for Studies on Experimental Animals".

Histological sections were prepared from fragments of operated on organs and stained with hematoxylin and eosin and by van Gieson method. Pathohistological picture of the autopsy material was evaluated. Percent volume of necrosis was evaluated on preparations by counting necroses in 5 visual fields using 100-point ocular systems [1]. Quantitative morphometric parameters were statistically processed, the means and errors of the means were estimated.

## RESULTS

The percentage of necrosis after gastrohepatoplasty was  $24.4 \pm 5.8\%$  on day 1, reached the peak ( $30.6 \pm$

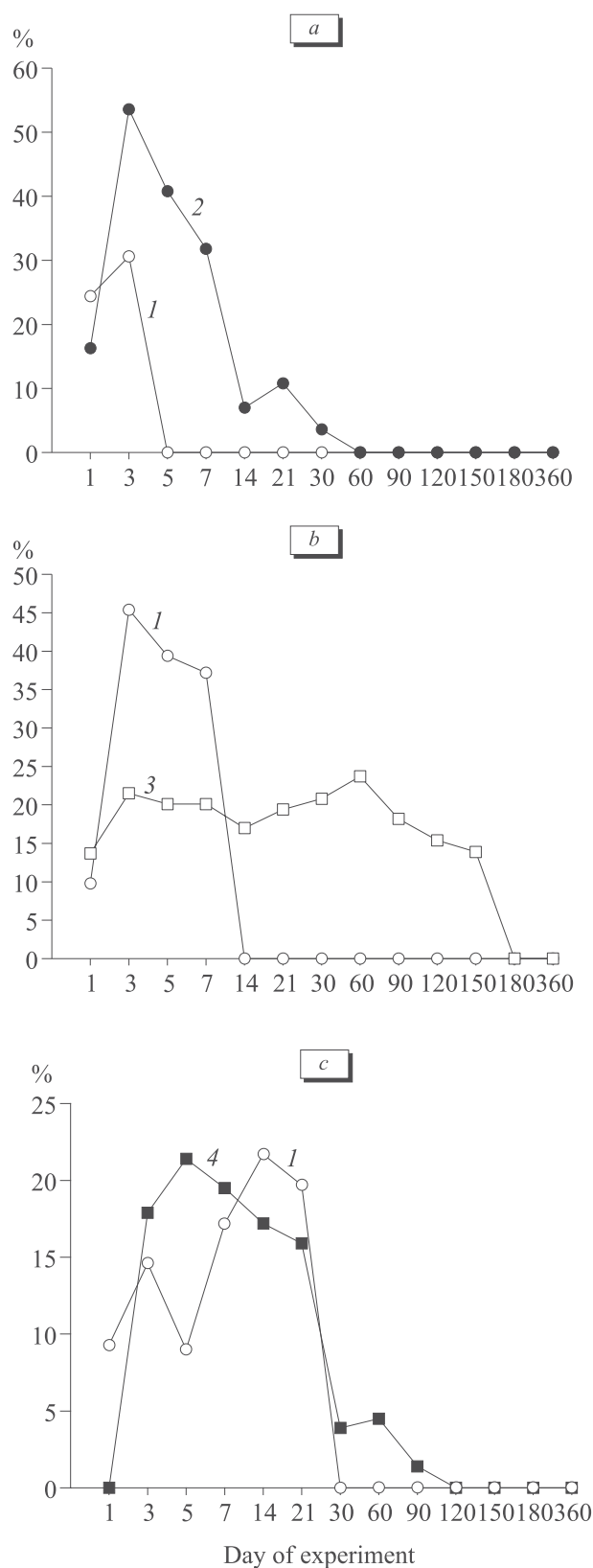
Astrakhan State Medical Academy; \*Russian Medical Academy of Postgraduate Education, Moscow, Russia. **Address for correspondence:** agma@astranet.ru. O. V. Musatov

9.9%) on day 3, and decreased to zero by day 5 (Fig. 1, *a*). After hepatorrhaphy, the volume of necrosis rapidly increased to  $53.60 \pm 1.12\%$  on days 1-3 and remained high ( $31.8 \pm 1.2\%$ ) until day 7, after which it gradually reduced and disappeared on day 60 after the intervention; this was 12-fold longer in comparison with the experimental group. Gastrolienoplasty was followed by the maximum increase in the studied parameter on day 3 ( $45.4 \pm 1.6\%$ ) and its complete disappearance by day 14 (Fig. 1, *b*). After omentolienoplasty, the maximum percentage of necrosis was recorded on day 60 ( $21.5 \pm 0.1\%$ ), after which they disappeared on day 180, which was 13-fold longer in comparison with experimental group. The renal wound repaired by SMFS nephroplasty was cleansed 4-fold sooner (on day 30) than after omental repair (on day 120; Fig. 1, *c*).

These data indicate that gastropasty of the liver, spleen, and kidney wounds led to the development of more productive inflammatory process with rapid cleansing of the wound, development of fine connective tissue cicatrix, and more adequate regeneration in general. After SMFS plasty, the wound surface was covered with the gastric submucosal layer producing angiogenic proteins [8] with numerous arteriovenous anastomoses and loose fibrous connective tissue. This treatment triggered the tissue diffusion mechanisms, due to which edematous fluid was evacuated from the organ wounds into the flap. It is noteworthy that liver wound after hepatorrhaphy had no tissue drainage at all. Comparative evaluation of SMFS and the greater omentum as beds for splenic tissue reimplantation after splenectomy demonstrated better plastic characteristics of SMFS [4].

Fixation of the greater omentum to the organ wound leads to occlusion of graft vessels, in more than 85% of its capillaries the fluid flows from the graft. In addition, the hydrostatic pressure of the omental capillary system surpassed the more effective colloid osmotic pressure for the entire system. Vasomotor activity in vessels of the greater omentum is virtually absent in anesthetized animals. Inflammation, necrotic changes, granulation, shrinkage, and fibrosis are often observed in omental areas adjacent to the wound [7]. Cases of infarction of the greater omentum were reported [6,9].

These data indicate that in contrast to SMFS, the greater omentum possesses no "draining" functions. The injury and the presence of devitalized tissue in the aseptic wound often promote the formation of wound cavities, persistent inflammatory reaction, and hence, delayed formation of the cicatrix [3]; it should be also noted that tissue degradation products are characterized by immunosuppressive effects [5]. Therefore, the inflammatory



**Fig. 1.** Volume percentage of necrosis after operations on the liver (*a*), spleen (*b*), and kidney (*c*). 1) wound coating by SMFS; 2) hepatorrhaphy; 3) omentolienoplasty; 4) omental nephroplasty.

regenerative processes in the control were protracted, with a long period of wound cleansing and development of fibrotic growths and coarse connective tissue cicatrix during the delayed period (60-360 days).

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