Urological Research 2, 29-31 (1974)

The Parenchymal Reaction of the Kidney after Local Freezing* **

H. Breining, B. Helpap, A. Minderjahn, and S. Lymberopoulos

Depts. of Pathology and Urology, RWTH Aachen, and Dept. of Pathology, University of Bonn, Germany (FRG)

Received: April 26, 1974

Summary. Histological and autoradiographic studies were performed to investigate the reparative processes during wound healing in kidneys after local freezing. 12 h after freezing (-186° C, 30 sec) the cryonecrosis is fully developed. After the 5th postoperative day the cryonecrotic area shows a pronounced calcification of necrotic tubules. 30 days after freezing the reparation of the cryolesion in the kidney results in a small fibrous scar. The proliferative activity of the kidney parenchyma is limited to a small tissue area surrounding the cryonecrosis and reaches a maximum between the 2nd and 3rd postoperative day. 30 days after freezing there are no differences between the labelling indices after injection of ^{3}H-thymidine one hour before killing the animals in frozen and in non frozen parts of the kidneys. These results are comparable to the findings in liver and spleen after deep freezing and underline the rapid repair of cryonecrosis in parenchymal organs especially in kidneys.

Key words: Cryonecrosis - reparative processes

In preservative renal surgery, cryosurgical methods have won increasing significance, because they produce a good hemostatic effect on capillary bleeding and because the freezing damage can be controlled by the temperature, freezing time and size of the frozen area (6). Histological studies have shown good wound healing in the kidney and liver after cryonecrosis, finally resulting in a small fibrous scar (1, 2, 4). Using tritium thymidine autoradiography, we examined the quantitative reparative and regenerative cell reaction in kidney parenchyma after local freezing (5). The biophysical basis of low temperature in biological cell systems has been described by Cooper, Mazur and Meryman (3, 10, 11).

Material and Methods

27 Wistar rats (180 gr) were anaesthetized with ether. After laparotomy, the left kidneys were frozen with a cryoscalpel (8) over an area of about 5 mm in diameter (30 sec, -186° C). The life span of the animals ranged between 0.5 and 30 days. One hour before killing, the rats were injected i. p. with 0.5 mC ^{3}H-thymidine. Both kidneys were fixed in formaldehyde. The autoradiographic studies were performed on 5 µ thick cuts, using stripping film (Kodak, AR 10). The autoradiograms were stained with haemalaun. The time of exposure was 19 days. In the autoradiograms the labelling indices of the tubular epithelium and of the mesenchymal cells were measured at the rim of the necrosis and at various distances from the frozen area, in the unfrozen parts of the frozen kidney and in the contralateral unfrozen kidney (5, 12).

Results

12 h after freezing complete necrosis of the frozen tissue had developed. At the 2nd day and

* Supported by Landesamt für Forschung, Düsseldorf

** Presented on the 2nd Symposium of Experimental Urology, March 7.-9., 1974, Köln

later there are many fibroblasts and other mesenchymal cells at the rim of the necrotic area. 2-4 weeks postoperatively only a little calcified connective tissue scar remained.

After labelling with ^{3}H-thymidine (Fig. 1), the first radioactive labelled mesenchymal cells appear at the rim of the necrotic zone 12 h after freezing. In the same area there is a maximum of labelled cells up to 35% between the 2nd and 3rd days as in the interstitium of the 300 µ wide unfrozen area. After this time, the labelling indices decrease. 30 days after freezing, there are no differences between scar tissue and unfrozen tissue.

There is a similar pattern of labelling indices of the tubular epithelium in the 300 µ wide zone surrounding the cryonecrosis. The maximum epithelial cell proliferation is seen on the 2nd postoperative day and the labelling indices decrease after this time very rapidly till to the 14th day.

Discussion

Cryonecrosis produces, in contrast to other mechanical and toxic parenchymal lesions of the kidney, a rapid onset of cell proliferation (4, 5). The proliferative stimulation is limited to the necrotic tissue area and can be detected as far as 300 µ from the rim of the necrosis. In the unfrozen parts of the same and of the contralateral kidney only a small proliferative activity at the 2nd and 10th postoperative day can be observed (5). These results are comparable to the cell proliferative activity within the freezing lesions of the liver and the spleen (4, 5) and underline the rapid repair of cryonecrosis.

In human renal cryosurgery one can avoid additional damage of the kidney parenchyma caused by temporary occlusion of the renal artery during conventional surgical methods (6-9).

References

1. Breining, H., Lymberopoulos, S., Langer, St.: Zur Morphologie des Nierenparenchyms nach lokaler Gefrierung. Beitr. Path. 142, 71-89 (1970)
2. Breining, H., Helpap, B., Lymberopoulos, S.: Local tissue freezing and its healing in liver and kidney. Germ. med. Mth. 2, 118-119 (1972)
3. Cooper, I.S.: Cryogenic surgery: A new method of destruction or exstirpation of benign or malignant tissue. New Engl. J. Med. 268, 743-749 (1963)
4. Helpap, B., Breining, H., Lymberopoulos, S.: Autoradiographische, histologische und histochemische Untersuchungen an der Rattenleber nach lokaler Gefrierung. Beitr. Path. 148, 165-179 (1973)
5. Helpap, B., Breining, H., Minderjahn, A., Lymberopoulos, S.: Die Wundheilung nach Kyronekrose an der Niere. Virch. Arch. in press
6. Lymberopoulos, S.: Kryochirurgie parenchymatöser Organe, insbesondere der Niere in Experiment und Klinik. Habil.-Schrift Aachen 1970
7. Lymberopoulos, S., Gierlichs, H.W., Rathert, P.: Comparative renographic studies after

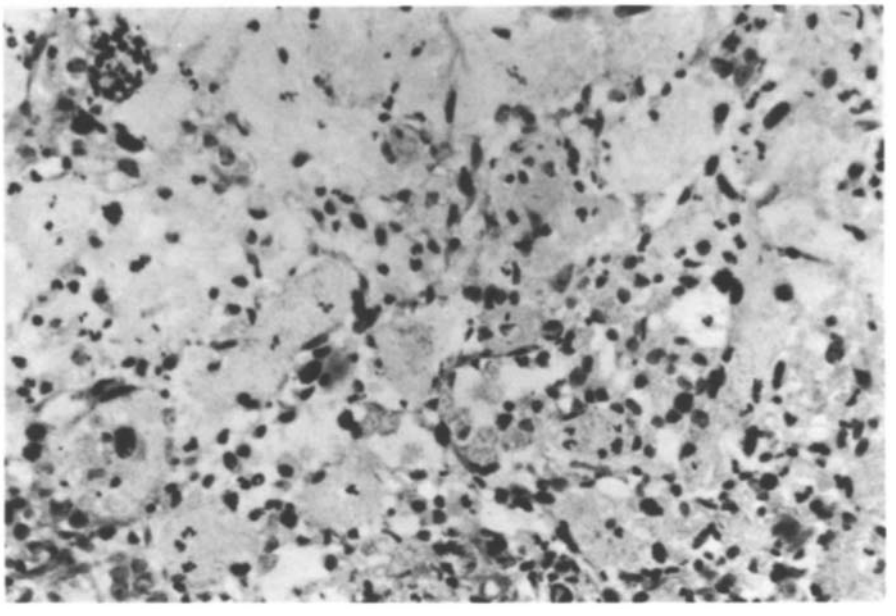

Fig. 1. Many labeled mesenchymal and epithelial cells in the surrounding parenchyma of the kidney after cryolesion (Strippingfilm-Autoradiogram)

cryosurgical kidney resections. In: Latest developments in Cryosurgery p. 223-231. Verlag Wiener Med. Akademie (1972)
8. Lymberopoulos, S.: Das Kryoskalpell - Kältetechirurgische Eingriffe an parenchymatösen Organen. Biomed. Technik 16, 148-151 (1971)
9. Lymberopoulos, S., Lutzeyer, W.: Klinische Erfahrungen bei der Kryochirurgie der Niere. Verh. dtsch. Ges. Urol. 154-159 (1971)
10. Mazur, P.: Causes of injury in frozen and thawed cells. Fed. Proc. 24 Suppl. 15, 175-182 (1965)
11. Meryman, H. T.: Mechanics of freezing in living cells and tissues. Science 124, 515-521 (1956)
12. Minderjahn, A.: Die zelluläre Reaktion der Rattenniere nach lokaler Gewebsvereisung. Diss. Bonn 1974

Prof. Dr. H. Breining
Abt. Pathologie
RWTH Aachen
D-5100 Aachen
Goethestr. 27-29
Federal Republic of Germany

Prof. Dr. B. Helpap,
Pathol. Institut der Univ.
D-5300 Bonn
Venusberg
Federal Republic of Germany