Urological Research 1, 127-130 (1973)

Experimental Investigation of the Relationship between Operative Technique and Renal Parenchymal Injury

F. Truss

Urological Department, University of Göttingen, Germany (FRG)

Summary. Subject: Experiments have been done in rats to discover whether kidney surgery "in situ" is preferable to complete exposure with its risks of decapsulation and more vigorous traction on the renal pedicle.

Methods: Kidneys exposed in situ were either decapsulated or subjected to intermittent traction before slices were taken for measurement of metabolic activity in a Warburg apparatus.

Results: Neither procedure caused any significant change from normal values.

Conclusions: The advantages of complete exposure of the kidney, thus making its free rotation possible, need not be foregone because of the theoretically greater risk of producing renal damage.

Key words: Kidney surgery, renal parenchymal injuries, renal metabolism.

During surgery, the anatomical, functional and cosmetic results of organ-conserving kidney surgery are mainly influenced by three factors: - (1) selection of the approach; (2) technique of kidney exposure; (3) degree of kidney damage.

As shown in Fig. 1, the interrelations between such factors considered as causes and the end result of renal damage may be very complex. The main risks are kidney damages and impairment of wound healing.

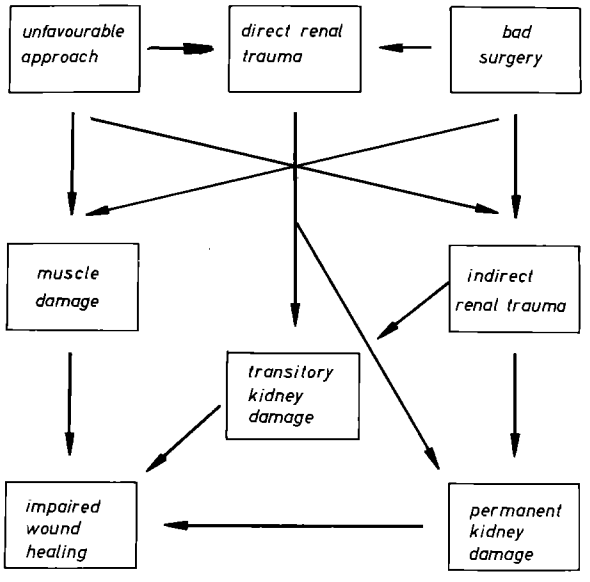

Fig. 1. Relationship between operative technique, renal parenchymal injuries and wound healing

In order to optimize that aspect of an operation which can best be judged subsequently by the patient himself, as well as his doctor, namely the condition of the postoperative scar, different muscle preserving incisions have been developed. It is, however, rarely possible to achieve the best possible result of preserving both the muscles and the kidney. Of all the incisions used at present, in the author's opinion the extended dorsal supracostal approach seems to be the best compromise; segmental nerves and vessels are preserved; and, only the latissimus dorsi and abdominal wall muscles are cut, the other back muscles being separated by blunt dissection. This approach makes it possible to dissect the kidney free, from its upper pole to the cranial ureter, and to rotate it around its three axes. It is suitable for many different types of operations, for example plastic repair of various malformations of the kidney, pelvis and upper ureter, removal of large, complex or multiple stones, partial resection etc.

There is no general agreement about the extent of the damage to the kidney caused either by its complete exposure or traction of its pedicle during rotation; and attempts to measure such damage objectively have not previously been undertaken. The present study was done to devise an animal experiment with which to develop cri-

teria for quantitative assessment of the extent of renal damage by operations on the kidney.

Material and Methods

The animals used were male albino rats (Wistar), weighing 200 - 300 g, that were kept under standard conditions. The left kidney was exposed transperitoneally under Nembutal anaesthesia. In Group I it was decapsulated and then replaced in the abdomen. In Group II the non-decapsulated kidney was suspended in a loop (Fig. 2), and the renal pedicle subjected to intermittent pulls of 50 g for one hour; a 5 min period of traction was followed by 5 min of rest. Afterwards, the kidney was replaced in the abdomen.

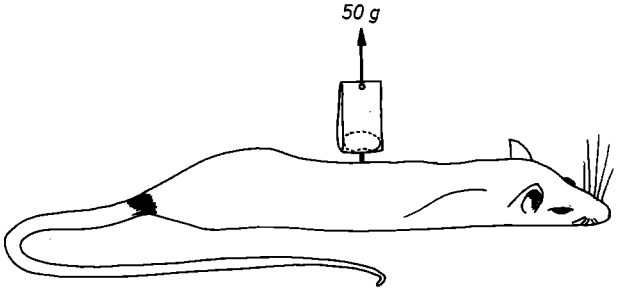

Fig. 2. Experimental arrangement for intermittent traction on the renal pedicle

The treated kidneys from both groups were removed after 1, 4, 6 or 21 days. Thin slices were cut from the renal cortex and were placed in a Warburg apparatus for the measurement of oxygen consumption, the transport capacity for p-aminohippuric acid (PAH-uptake) and anaerobic glycolysis. Alkaline phosphatase activity (AP) was measured in a homogenate of cortical tissue prepared with a manual homogenizer. All the values obtained were compared with those found in rat kidneys that had not been operated on.

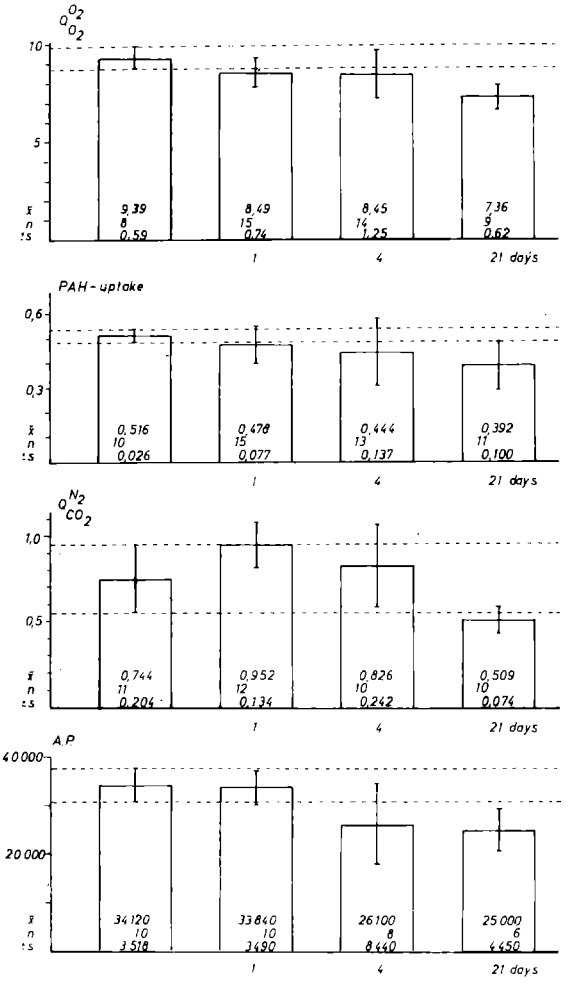

Fig. 3. Oxygen consumption ($Q^{O_2}_{O_2}$), PAH-transport, anaerobe glycolysis ($Q^{N_2}_{CO_2}$) and tissue activity of alkaline phosphatase (AP) in ghe renal cortex of the rat, 1, 6 and 21 days after decapsulation. The dotted lines show the normal range

Results

All the animals survived.

Group I: 24 h after decapsulation, oxygen consumption and PAH-transport capacity were at the lower threshold of normal, and anaerobic glycolysis was at the upper limit of normal. Tissue activity of alkaline phosphatase was unchanged. Four days after trauma, anaerobic glycolysis had returned to normal and the tissue activity of alkaline phosphatase had decreased (Fig. 3). Three weeks after the operations all the values tended to be slightly below normal.

Group II: Measurements were made 1, 6 and 21 days after traction on the renal pedicle. As shown in Fig. 4, there were no striking differences from the normal controls in the parameters measured.

Discussion

Postoperatively, the extent of unilateral kidney injuries cannot be determined by simple methods of investigation. The results of conventional laboratory tests on serum and urine remain within normal limits because of the compensatory increase in function by the contralateral normal kidney. Measurement of the metabolic activity of the renal cortex of an experimental

animal is a useful means of studying minor kidney injuries; and, the most sensitive parameters have been found to be tissue activity of alkaline phosphatase, and PAH-tubular transport capacity. Oxygen consumption is the least sensitive index of damage. Figs. 5 and 6 show the reactions expected in clearly defined kidney damage.

Shortly after exposure and decapsulation of the kidney, no marked abnormality of renal metabolism was observed (Fig. 3). The slight changes found probably reflect damage to the superficial cells of the cortex caused by tearing off the renal capsule.

The loss of function observed 3 weeks after surgery was presumably due to perirenal scarring and cicatrization of the superficial cell layer of the cortex. The relative proportion of scarring would be much higher in the small kidney of the rat than, for example, in the much larger kidney of man.

Intermittent traction on the renal pedicle, too, failed to produce any detectable metabolic changes. This was surprising in view of considerable force employed; the 50 g pulled the aorta to one side and might even lift the rat slightly from the table. This, too, might have been expected to produce marked irritation of the perivascular sympathetic

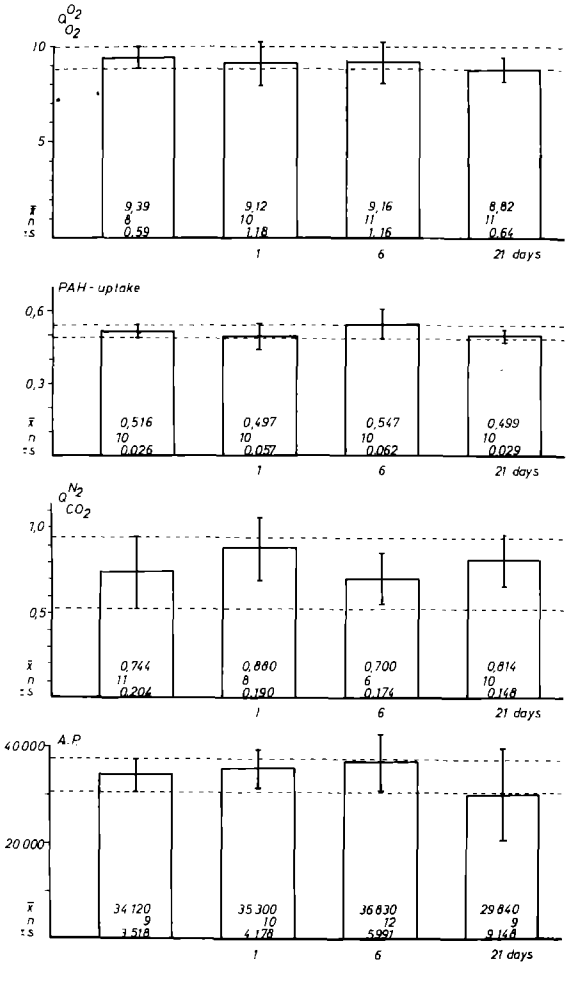

Fig. 4. Oxygen consumption ($Q_{O_2}^{O_2}$), PAH-transport, anaerobic glycolysis ($Q_{CO_2}^{N_2}$) and tissue activity of alkaline phosphatese (AP) in the renal cortex of the rat, 1, 4 and 21 days after intermittent traction on the renal pedicle. The dotted lines show the normal range

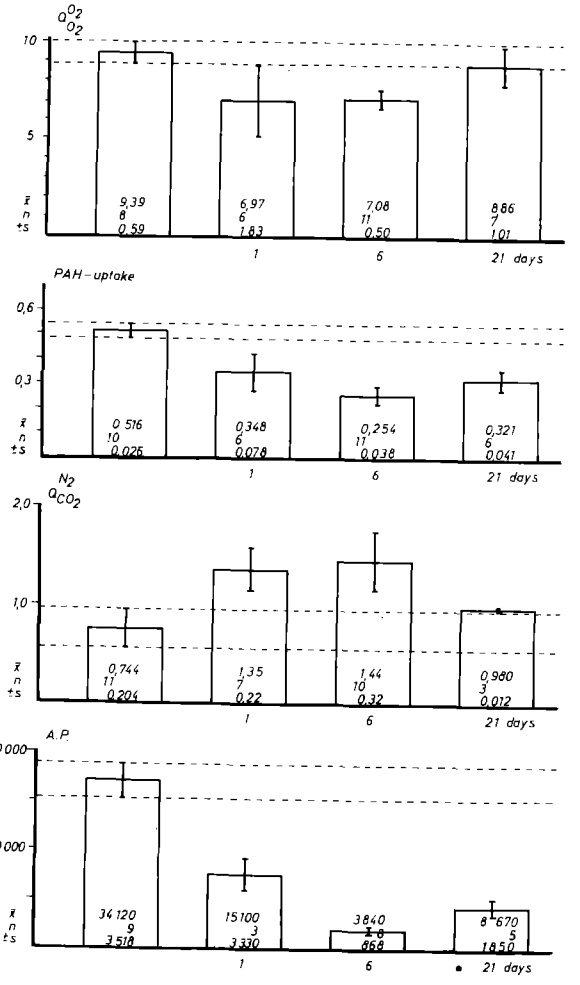

Fig. 5. Oxygen consumption ($Q_{O_2}^{O_2}$), PAH-transport, anaerobic glycolysis ($Q_{CO_2}^{N_2}$) and tissue activity of alkaline phosphatase (AP) in the renal cortex of the rat, 1, 6 and 21 days after 2 h of warm renal ischaemia. The dotted lines show the normal range

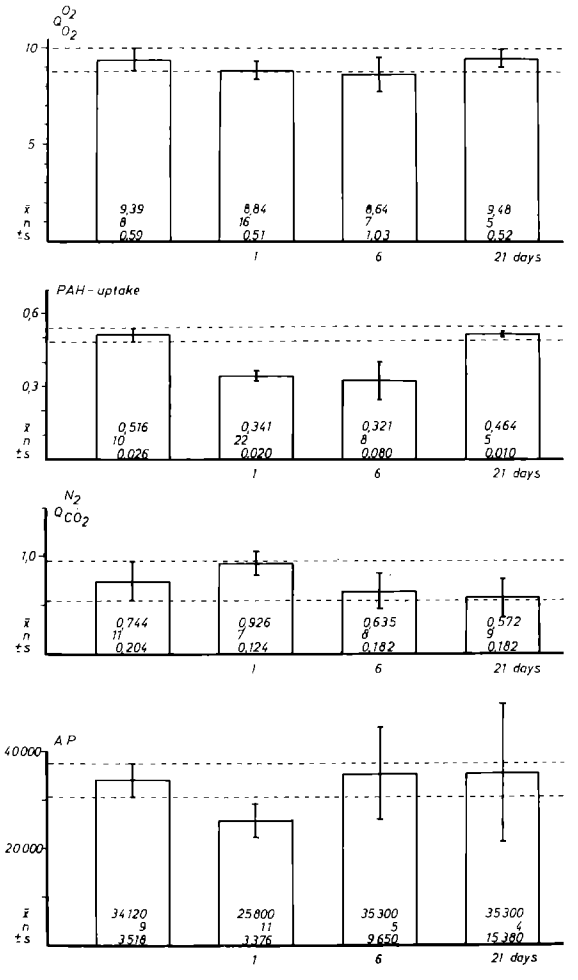

Fig. 6. Oxygen consumption ($Q_{O_2}^{O_2}$), PAH-transport, anaerobe glycolysis ($Q_{CO_2}^{N_2}$) and tissue activity of alkaline phosphatase (AP) in the renal cortex of the rat, 1, 6 and 21 days after 2 h of hypovolaemic shock at a systolic bloos pressure of 50 mm Hg. The dotted lines show the normal range

nerve plexus of the renal pedicle. However, there was no evidence of a reflex type of renal failure.

The results of animal experiments cannot be transferred to man without reservation. Since, however, the physiological behaviour of rat and human kidneys in general is very similar, it is not too far fetched to decuce general clinical applications from experimental results. It seems likely that general factors, such as a fall in blood pressure, insufficient oxygen supply etc. may play a more important role in causing renal damage than mere manipulation of the kidney by the surgeon.

In conclusion, the fear of producing renal parenchymal injury should not force a surgeon under any circumstances to attempt a difficult organ - conserving operation on a kidney left in situ, and through an incision designed to preserve as much muscle as possible. Compared to the kidney, muscle is a far less sensitive and valuable tissue, and surgeons should be prepared to sacrifice some of it so as to avoid a difficult approach to the kidney that may endanger the result of the operation. The present experimental results lend support to the view held by experienced urological surgeons that full and proper exposure is essential in operations on the kidney and that it must take precedence over conservation of muscle and cosmetic considerations.

References

Lutzeyer, W., Lymberopoulos, S.: Der lumbodorsale Zugang zur Niere (Lurz). Indikation, klinische Erfahrungen und kritische Beurteilung. Urologe A 9, 324 (1970).

Truss, F.: Advantages and disadvantages of intermittent pedicle clamping in renal preserving surgery. Brit. J. Urol. 43, 35 (1971).

Truss, F.: Prophylactic and therapeutic Trasylol administration in experimentaly reduced renal circulation. New Aspects of Trasylol-Therapy. Stuttgart, New York: F.K. Schattauer 1971.

Professor Dr. F. Truss
Chirurgische Univ.-Klinik
Urologische Abteilung
Universität Göttingen
D-3400 Göttingen
Federal Republic of Germany