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FIRST CLINICAL EXPERIENCE WITH EXTRACORPOREALLY INDUCED DESTRUCTION OF KIDNEY STONES BY SHOCK WAVES

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We performed extracorporeally induced destruction of kidney stones on 72 patients. No complications have resulted from the tissue exposure to high energy shock waves. Clearance studies before and after the shock wave treatment indicate no changes in renal function. The method was used successfully in all patients with stones in the renal pelvis. In none of these patients was an open operation required. Two patients with ureteral stones also were treated with shock waves but had to be operated upon because of insufficient destruction of the stone.

With a morbidity rate of 2 to 3 per cent of the total population kidney stone disease can be compared to the morbidity rate of diabetes. However, little is known about the mechanism of stone formation. Therefore, causal treatment or an effective prevention of recurring kidney stones is not possible in most cases and, frequently, surgical removal remains the only therapy.

We report on our experience with high energy shock waves as applied for extracorporeal, contact-free destruction of renal calculi in patients. The principle of the procedure is extracorporeal generation and administration of shock waves directed at the renal calculus as target.[1,2]

METHOD

Shock waves are produced by an underwater high voltage condenser spark discharge 1 microsecond in duration (fig. 1). The spark electrodes are localized in the geometric focus of an ellipsoid reflector. High voltage discharge of the spark causes an immediate explosive evaporation of the surrounding water, which leads to the generation of shock waves through the surrounding fluid because of the sudden expansion.

Since the shock wave emission center is localized in the focus of an ellipsoid the waves are reflected from the surrounding wall and collected again in the second focus. Thus, the second focus is the area of highest energy density.[3,4] Therefore, it follows that the kidney stone must be adjusted in this particular area. To accomplish this, 2 independent x-ray conversion systems with separate axes are used. The crossing point of the axes is the second ellipsoidal focus. The patient is positioned over the ellipsoid so that the kidney stone is centered in the cross-hairs of each x-ray system.

The first 14 patients were treated under general anesthesia, while all others underwent peridural anesthesia, which was found to be sufficient. The only exceptions were 2 children who were treated also under endotracheal anesthesia. For shock wave treatment the anesthetized patient is placed on the integrated bench, which can be moved over the ellipsoid by motor engines. In this way the patient is placed in the water bath, which is necessary to allow the shock waves to enter the body.

By means of the positioning device the patient is placed over the ellipsoid. Approximately 500 to 1,000 single shock

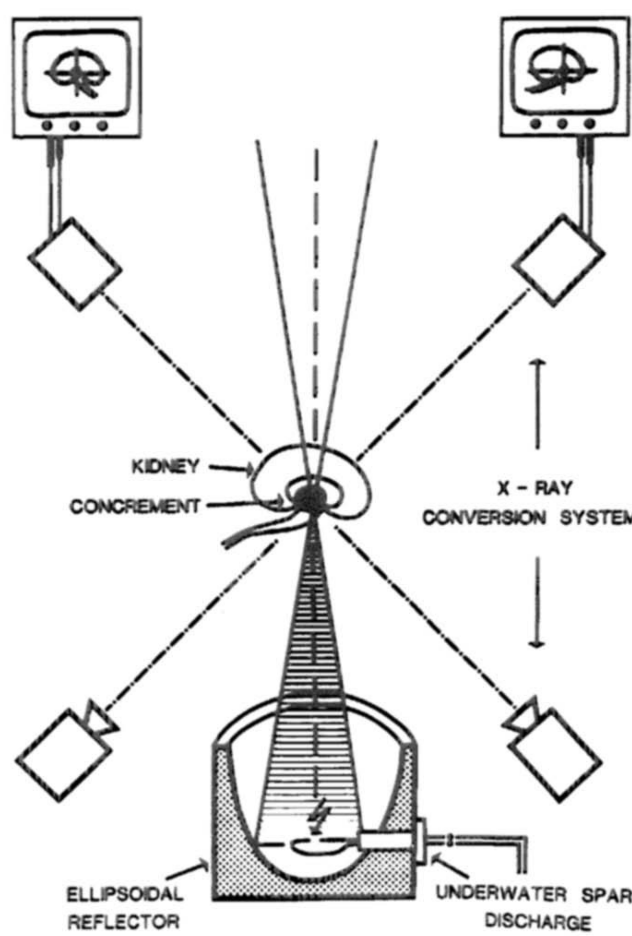

FIG. 1. Construction for extracorporeally induced destruction of kidney stone with 2 integrated x-ray conversion systems.

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wave exposures, each with a duration of 0.5 microseconds and a pressure amplitude in the kilobar range, are needed to destroy the kidney stone. The complete procedure, including positioning the patient and correcting the adjustment and shock wave exposure of the stone, lasts 30 to 45 minutes.

The first series was done under various limitations. High risk patients with cardiopulmonary problems were excluded from study. However, these patients may be treated after more experience has been gained. This method is contraindicated in patients with intrarenal obstruction unless a percutaneous nephrostomy tube is inserted beforehand. However, most of these cases require an operation anyway to establish undisturbed urinary outflow. At first, patients withurinary tract infection also were excluded but, later, somepatients with infection were treated successfully under antibiotic therapy.

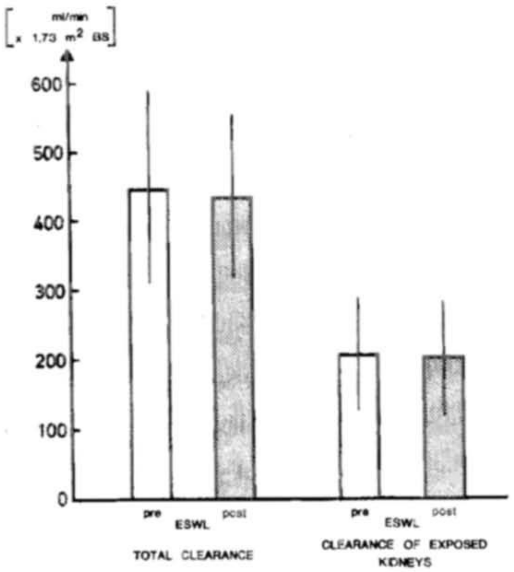

FIG. 2. Values of ^{131}iodine hippuran clearance before and after shock wave treatment.

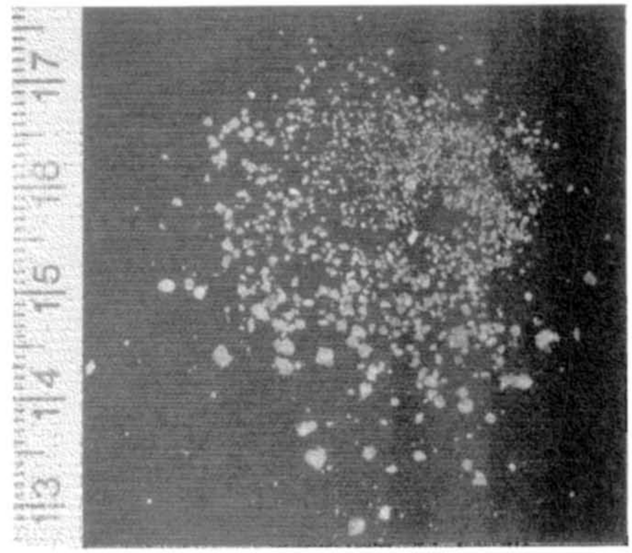

FIG. 3. Particles of oxalate stone passed in urine of treated patients.

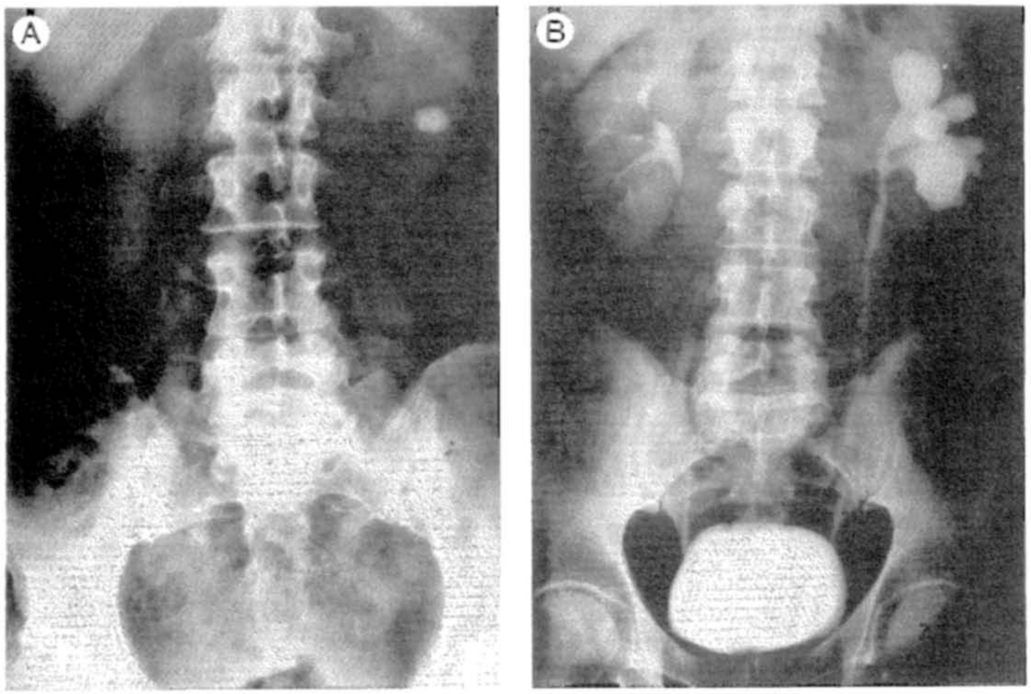

FIG. 4. *A*, stone in renal pelvis before treatment. *B*, excretory urogram shows unilateral obstruction on right side