Effect of Extracorporeal Shock-Wave Lithotripsy on Gallbladder Emptying in Patients with Solitary and Multiple Gallbladder Stones

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In a prospective study, we investigated the effect of extracorporeal shock-wave lithotripsy (ESWL) on gallbladder contractility and on fasting and residual gallbladder volume in patients with solitary and multiple gallbladder stones with stone densities < 100 Hounsfield units (HU) and adequate gallbladder function. Twenty-five patients (seven males and 18 females, mean age 48.5 ± 11.7 years) treated with ESWL were assigned to either group I, consisting of 13 patients with solitary stones < 20 mm diameter, or group II, including patients with two to three stones and maximum stone diameter of 30 mm. ESWL was performed with the MPL 9000 lithotripter. Gallbladder ejection fraction was determined using the method of Dodds after a 12-hr fast and following application of a standard stimulative meal. Gallbladder volume was measured by ultrasound over 90 min at 10-min intervals before ESWL, then at 1, 30, 120, and 210 days after ESWL. At 24 hr after ESWL, residual gallbladder volume increased in group I from 7.4 ml to 13.9 ml (P = 0.0567) and in group II from 6.5 ml to 20.2 ml (P = 0.0076). Thereafter, residual volumes returned to pre-ESWL levels. In group II, post-ESWL fasting volumes were significantly increased over initial values at all time intervals. Correspondingly, only at 24 hr after ESWL, ejection fractions decreased from 73.1% to 64.9% in group I and from 76.5% to 62.7% in group II. No statistically significant differences in gallbladder contractility between the two groups were observed at any point of the follow-up period. ESWL exerts a no more than transient effect on gallbladder motility, regardless of stone count prior to ESWL. We postulate that changes in residual gallbladder volume and reductions in ejection fraction may be due to transitory disturbances in the gallbladder epithelium and resultant gallbladder wall edema.

KEY WORDS: gallbladder function; extracorporeal shock-wave lithotripsy; stone clearance; gallbladder CT; Hounsfield units; prognostic factors.

In selected patients suffering with gallbladder stones, extracorporeal shock-wave lithotripsy (ESWL) with adjuvant oral cholelitholysis represents a safe and effective conservative therapeutic modality and may be considered the treatment of choice in about 10% of symptomatic patients (1, 2). In these patients, complete stone clearance can be expected in 80–90% of cases treated (2–8). Stone count and diameter are generally recognized to be decisive selection criteria (4, 6). The relevance of physical stone density and gallbladder function, however, remains controversial and both these parameters continue to be the subject
of ongoing clinical investigation (9–14), particularly with regard to their prognostic value in assessing the risk of recurrence following stone clearance (15–17).

Several research groups have reported consistent findings with respect to gallbladder motility disturbances in both animal models and human gallstone patients (18–25). Furthermore, an increased gallbladder fasting volume has been reported during bile acid therapy (24, 26, 27). Both chenodeoxycholic acid (CDCA) and ursodeoxycholic acid (UDCA) have been associated with increases in the gallbladder ejection fraction (26, 27).

ESWL's effect on gallbladder function itself, however, remains controversial. Whereas Spengler et al found no difference between pre- and post-ESWL gallbladder function, regardless of concomitant oral bile acid administration (28), Rothstein et al observed a transient disturbance in gallbladder emptying, which, however, returned to normal within six weeks (9). In a recent study reported by Sackmann et al, two patient collectives, with and without residual stone fragments, were compared retrospectively 18 months following ESWL (10). The investigators found that patients with complete stone clearance exhibited a twofold better degree of gallbladder contractility than did patients with residual stones. Additionally, an increased gallbladder fasting volume was observed in the group with residual stones, although this difference was not statistically significant (10).

In the present study, we investigated the effect of ESWL on gallbladder contractility, gallbladder fasting volume, and residual volume in patients with solitary and multiple gallstones and stone densities <100 Hounsfield units (HU) at computed tomography (CT) of the gallbladder.

**MATERIALS AND METHODS**

**Patients.** Twenty-five patients (seven males and 18 females, average age 48.5 ± 11.7 years) presenting for ESWL of gallbladder stones were included in our prospective study of the influence of extracorporeally applied shock waves in gallbladder contractility and gallbladder fasting and residual volumes. The patients were divided into two groups on the basis of the following criteria.

Group I (five males, eight females) included patients with solitary stones <20 mm in diameter. Group II (two males and 10 females) was made up of patients with two to three gallbladder stones with a maximum stone diameter of 30 mm. All patients exhibited stone densities at gallbladder CT of less than 100 HU and sonographically assessed gallbladder ejection fractions of at least 30%.

**ESWL.** All ESWL treatments were carried out with the patient in the supine position using a second-generation electrohydraulic lithotripter (MPL 9000, Dornier Medizin-technik, Munich, Germany). During the procedure, oxygen was administered at 6 liters/min, and patients were monitored via continuous blood pressure measurement and by means of the ECG leads required for the ECG-triggered shock wave application. Sedoanalgesia was administered in the form of piramidate, promethazine, and midazolam. The technical data are presented in Table 1.

**Gallbladder Motility.** Gallbladder fasting volume and contractility were measured sonographically after a minimum 12-hr fasting period utilizing the method described by Dodds et al (29). We used a UM4 ultrasound unit with a 3.5- or 5-MHz ultrasound head supplied by Advanced Technology Laboratories (Bothell, Washington). Gallbladder contraction was induced by means of a defined stimulative meal consisting of 20 g sugar substitute (= 19.978 g sorbitol and 0.022 g saccharin, 339.6 kJ = 80.8 kcal) and 20 g powdered whole hen's egg.

After determining gallbladder fasting volume (V₀) by means of two measurements at 10-min intervals and following application of the stimulative meal, gallbladder volumes were measured at 10-min intervals over a period of 90 min. Residual volume (Vₘᵡᵣ) was taken to be the average of the two smallest measured gallbladder volumes, once active contraction had ceased. The degree of gallbladder contraction, expressed in percent of the fasting volume, was obtained using the following formula:

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\frac{[V₀ - Vₘᵡᵣ]}{V₀} \times 100\% = \text{gallbladder ejection fraction in } \%
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