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EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY MONOTHERAPY WITH THE NEW DORNIER MPL-9000 LITHOTRIPTER

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Dornier MPL-9000쇄석기를 이용한 요로결석치료의 경험

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=국문초록=

현재 12가지가 넘는 다양한 종류의 쇄석기가 사용되고 있으나 Dornier MPL-9000은 요로결석과 담석의 치료를 위해 최근 개발된 제3세대 쇄석기로 타쇄석기에 비해 높은 성공율 및 안정성이 보고되고 있다.

본교실에서는 1990년 12월부터 1992년 4월까지 요로 결석 환자 155례에 대하여 Spark gap type의 Dornier MPL-9000쇄석기를 이용하여 체외충격파 쇄석술을 시행하여 얻은 결과를 보고하는 바이다.

결석의 위치는 신결석 95례(61.2%), 요관결석 57례(36.8%), 방광결석 3례(1.9%)였으며, 크기는 0.5cm부터 4.8cm까지로 평균 1.4cm이었다. 시술횟수는 한 환자에서 1-5회로 총 217회 였으며 평균 1.4회였다. 전체 결석 분쇄율은 1회 쇄석술후 71.6%, 추가 재시술후 98.1%의 성공율을 보였으며 1회 쇄석술후 위치별 완전 분쇄율은 신결석이 75.7%였고 요관결석이 70.1%였고 크기별 완전 분쇄율은 1cm미만 결석87%, 1cm에서 2cm결석 73%, 2cm이상에서 5%였다. 보조시술로는 요관결석에 대한 push-up 29례(18.7%), 요관 카테터 우회 3례(1.9%), 신장결석에 대한 요관 부목 유치 2례(1.3%)를 시행하였다. 시술시 통증이 있은 86회(39.6%)중 진통제를 필요로 한 경우가 36회(16.6%)였으나 치료를 중단한 예는 없었다. 합병증으로는 육안

적 혈뇨 115례(74.2%), 요관 돌길형성 24례(15.5%), 산통 10례(6.4%) 오심 11례(7.0%) 혈압변화 3례(1.9%), 발열 3례(1.9%)등이었다.

위의 결과로 요로결석에서 Dornier MPL-9000쇄석기를 이용한 단독치료는 안전하고 효과적인 우선적 치료방법으로 생각된다.

Key Words : Dornier MPC 9000, ESWL

INTRODUCTION

Since its introduction by Chaussy and associates in 1980 extracorporeal shock wave lithotripsy(ESWL) has proved to be a safe and effective noninvasive method to treat patients with urinary tract calculi. ESWL has become the preferred method of treatment in majority of all cases of urolithiasis.

From December, 1990 to April, 1992 we treated 155 patients with urinary tract calculi with the new multipurpose third generation lithotripter Dornier MPL-9000 lithotripter has been evaluated over 15 months for safety and efficacy. In addition to an inline and outline ultrasound positioning system is an equipped system capable of reaching stones in the whole urinary tract system.

We report here our experience with ultrasound-guided Dornier MPL-9000 lithotripter for lithotripsy treatment of whole urinary tract stones.

Material and Method

From December, 1990 to April, 1992 for 15 months we treated 155 patients with stones of whole urinary tract which were categorized by age, sex, location and size of stones with Dornier MPL-9000 lithotripter. We studied the success rate according to size, location of stone, frequency of sessions and also complications that occured. Before the ESWL treatment, we checked CBC, blood coagulation test, urinalysis, urine culture, LFT, EKG, electrolyte and IVP. Befor the treatment we used plain film to identify the location of the stone. During the treatment when severe pain occured we used sedoanalgesics. One day after the treatment, we confirmed the disintegration of stones on plain film KUB control films were taken after 1 week, 3 weeks and 12 weeks.

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Results

From December, 1990 to April, 1992 there were 217 treatments performed on 155 patients by using the Dornier MPL-9000 Lithotripter with ultrasound locating system : 100(64.5%) in male and 55(35.5%) in female patients. The age of the patients

Table 1. Age and sex distribution

Age	Sex		Rate No.(%)
	Male No.	Female No.	
<20	2	0	2(1.2)
20-29	9	4	13(8.4)
30-39	30	11	41(26.5)
40-49	32	16	48(30.9)
50-59	17	17	34(21.9)
60-69	9	3	12(7.7)
70-79	1	4	5(3.2)
Total No.(%)	100(64.5)	55(35.5)	155(100.0)

Range : 18-76(Mean : 44.2)

Table 2. Location and size of stone

Location	Stone size(cm)			Total No.(%)
	<1.0 No.(%)	1.0-2.0 No.(%)	>2.0 No.(%)	
Kidney	50(2.2)	28(18.1)	17(10.9)	95(61.2)
Calices	46(29.6)	22(14.2)	5(3.2)	73(47.0)
Pelvis	4(2.6)	6(3.9)	12(7.7)	22(14.2)
Ureter	35(22.6)	20(12.9)	2(1.3)	57(36.8)
Upper	16(10.3)	13(8.4)	2(1.3)	31(20.0)
Lower	19(12.3)	7(4.5)		26(16.8)
Bladder	1(0.6)	1(0.6)	1(0.6)	3(1.9)
Total No.(%)	86(55.4)	49(31.6)	20(13.0)	155(100.0)

Range of stone : 0.5-4.8cm(Mean : 1.4cm)

Table 3. Success rate according to size of stone(1st session)

Size(cm)	Rate(%)
〈 1.0	87(75/86)
1.0-2.0	73(36/49)
〉 2.0	5(1/20)

Table 4. Success rate according to location(1st session)

Location	Rate(%)
Kidney	75.7(72/95)
Ureter	70.1(40/57

Table 5. Success rate according to No. of session

No. of session	No. of patient(%)	Success rate(%)
1st session	114(73.5)	71.6
2nd session	28(18.6)	89.7
3rd session	6(3.9)	93.5
4th session	6(73.9)	97.4
5th session	1(0.6)	98.1

Table 6. Amplitude and number of shock waves during one session

Kilovolt	Number of shock wave
14	151.5
15	134.8
16	417.2
17	786.1
18	1141.1
19	460.0
20	450.6

ranged from 18 to 76 years with an average of 44.2 of an age(Table 1). The stone distribution was the followings : 95 patients (61.2%) in the kidney : 57 patients(36.8 %) in the ureter and 3(1.9%) patients in the bladder. The average stone size was 1.4 cm with a range from 0.5 to 4.8cm(Table 2). The total ESWL success rate was 98.1 percent. 111 patients(71.6%) could be rendered stone free with only one single session. The distribution of the success rate according to size with only one single session has been as follows : 87 perceent for less than 1cm. 73 percent for 1 to 2cm and 5 percent for above 2cm(Table 3). The distribution of the success rate according to location with only one single session has been as follows : 75.7 percent for kidney

and 70.1 percent for ureter(Table 4). The total number of sessions was 217, with a re-ESWL rate of 1.4 sessions per patient accordingly. The overall retreatment was 26.5 percent. A second session treatment was necessary in 28(18.6%) cases, a third treatment in 6(3.9%), a 4th treatment in 6(3.9%) and a 5th treatment in 1(0.6%) case(Table 5). Three patients were not followed. The total number of applied shock waves per single treatment was 1800± 500 in average. The mean generator voltage setting was 18± 1KV(Table 6). The cause of booster session has been as follows : 15(9.7%) patients for staghorn or large calculi, 13(8.4%) patients for impacted ureter or UPJ stones, 7(4.5%) patients for poor localization, 1(0.6%) patients for migration of stone and 5(3.2%) patients for stone street(Table 7). The average treatment time per session has been 62.5 minutes(Table 8). During the ESWL treatment, intravenous analgesia with Demerol(1㎎/㎏) was necessary in only 16.6% of stone street, of these patients 19 cases were passed spontaneously without intervention and 5 cases were treated with booster ESWL(Table 9). Mild or colicky pain occured after ESWL in 10 patients(6.4%) and they were managed by sedoanalgesics. Nausea occurred in 11 patients(7.0%) and fever was observed in 3 patients(1.9%) after treatment. Gross hematuria that continued for more than 1 day after ESWL was noted in 18 patients (11.6%) but this mostly disappeared by 2 days after ESWL. No medical intervention was necessary in all these cases. In 3(1.9%) patients systolic blood pressure increased above 180㎜Hg after ESWL(Table 9).

Discussion

Since the first patient was treated successfully for a renal calculus with extracorporeal shock wave lithotripsy by Chaussy and associates[1] in 1980, rapid acceptance and widespread use have made this form of stone therapy for the treatment of choice with more than 80 percent of all renal calculi worldwide. Clinical series have documented the efficacy of extracorporeal shock wave lithotripsy for renal and ureteral calculi[6,10,11]. The physics of high-energy shock waves are used in the same way in all currently available lithotripters. A high energy amplitude of pressure(shock wave) is generates in water by the abrupt release of energy in a small space.

These sound waves are transmitted according to the laws of acoustics through water and soft tissues with little attenuation(decrease in energy) because these materials have similar densities. When the shock wave encounters the boundary between substances of differing densities or acoustic impedances, the tensile strength of that object may be overcome by the compressive stresses generated. The contact of a shock wave of sufficient energy with a stone produces a compression wave along the front face of the stone, causing the anterior surface to crumble. As the shock wave traverses to the posterior surface of the stone, part of the energy is reflected, creating tensile stress and fragmentation along this surface. Repeated shock waves focused on stress and fragmentation along this surface. Repeated shock waves focused on the stone eventually reduce it to many small fragments that may be passed spontaneously, the compressing-tensile wave phenomenon results in an implosion, thus minimizing the total kinetic energy of the fragme-

nts by using a large number of shock waves. This finding, supported by extensive clinical research, explains the low incidence of adjacent tissue injury during stone fragmentation with high energy shock waves.

All lithotripters share four main features : in energy source, a focusing device, a coupling medium, and a stone localization system. Although the basic principles of shock wave lithotripsy remain unchanged, a myriad of technological advances and modifications in the currently available lithotripters have significantly expanded the clinical applications of lithotripsy, Dornier MPL-9000 a third generation lithotripter is used in which the electrohydraulic shock wave generator is located at the base of water bath and produces shock waves by an electric spark gap of 15,000 to 25,000 volts of 1 microsecond duration, This high voltage spark discharge causes rapid evaporation of water, which generates a shock wave by expanding the surrounding fluid. The electrohydraulic generator is located with an ellipsoidal reflector that concentrates the reflected shock waves at the second focal point. The lithotripters gave wider apertures of the ellipse and lesser overall energy intensity of the shock wave generator stone localization during lithotripsy accomplished with either fluoroscopy or ultrasonography.

Fluoroscopy provides the urologist with a familiar modality and has the added benefit of effective ureteral stone localization. However, fluoroscopy requires more space and carries the inherent risk of ionizing radiation to both the patient, medical staff, and is not useful in localizing radiolucent stones without radiation exposure. Additionally, ultrasound is effective in localizing stone fragments as small as 2 to 3㎜ and is as good as or better than routine plain films to assess patients for residual stone fragments after lithotripsy. The ultrasound-based machines also have the important capability of gall stone localization for biliary lithotripsy.

Stone localization is a factor that determines the ease with which a stone is fragmented by shock waves. The stone localization is done by double ultrasound, which is made up of a lateral ultrasound that is composed of a flexible articulated robot arm and coaxial(in-line) scanner that also functions as final localization[5].

The stone free rate of lower calyceal stones was less than 60 percent in comparison to mid or upper calyceal stones which was 75 to 80% and pelvis or upper ureter stones which was 85 to 92 percent[3,13]. In our study the success rate between kidney and ureter was higher. Especially in ureteral stones, using maximal bladder distension and the iliac vessels as identification marker helped in localization of stones located in the upper part of the pelvic ureter and in the mid ureter. Juxtavesical stones were easily locallized with a partially filled bladder, as maximal distension(mainly in obese patients) cause an upward movement of the lower ureter and a naturally deeper penetration of the shock waves is needed.

Stone size also is a factor that influences the results of ESWL. In many experiences the so called easy ESWL stones were less than 2㎝ in size where as problems in achieving sufficient stone disintegration and stone passage principally were correlated with larger stones[2]. Many investigators reported that stones of less than 2 to 2.5㎝ were clear indications for ESWL and the critical stone size for ESWL monotherapy was approximately 3㎝ in diameter[4,7,17].

Table 7. Cause of booster session

Causes	No. of patients(%)
Staghorn or large calculi	15(9.7)
Impacted ureter or UPJ stone	13(8.4)
Poor localization	7(4.5)
Migration of stone	1(0.6)
Steinstrasse	5(3.2)

Table 8. Duration of ESWL treatment

Duration(min)	No. of session(%)
〈 30	28(12.9)
31−60	102(47.0)
61−90	65(30.0)
〉 90	22(10.1)
Total	217(100)

Table 9. Complication of ESWL and their management

Complication	No.(%)	Management
Gross hematuria		
〈 1 day	97(62.6)	None
1−2 days	15(9.7)	None
〉 3 days	3(1.9)	None
Steinstrasse	24(15.5)	Spontaneous expell : 19(12.2)
		Booster ESWL : 5(3.2)
Renal colic	10(6.4)	Sedoanlgesics
Nausea	11(7.0)	None
BP change	3(1.9)	Medical treatment
Fever	3(1.9)	Medical treatment
Sepsis	0	

Recently, the indication for ESWL has been extended to include the treatment of staghorn calculi. With treating a stone greater than 3㎝ by ESWL monotherapy, the success rate was 30 percent but combined percutaneous and extracorporeal shock wave lithotripsy represented a success rate of 85-95 percent[3,12,16].

However when Vandeursen and associates[2] performed ESWL monotherapy to treat staghorn calculi on 50 cases a success rate of 74 percent was reported.

In our study, out of 5 cases with ESWL monotherapy to treat partial staghorn calculi, in 4 cases the success occured in 4 sessions, in 1 case success occurred in 5

sessions. However unlike the Vandeursen's report, we did not observe sepsis.

Lingemann and associates[5] reported that a 3 month follow up of 569 patients showed 96 percent success results. which is defined as having no stones(72%) or the presence of only clinically insignificant fragments(24%). Among the patients with solitary renal stones less than 2㎝ in diameter, 91.3 percent were free of stones. Drach and associates 5 reported a success rate of 77.4 percent in 1987 treatments of patients with a single stone. Eisenberger and than 2 ㎝ in diameter. These success rates were obtained with the Dornier HM-3 lithotripter. In regard to second generation machines, a success rate of 46 percent in 1 session was reported with Wolf lithotripter[3]. A 61 percent rate free of stones was obtained with Siemens Lithostar[15] and residual stone rate of 46 percent was obtained with the Dornier HM-3 device.

Kim and associates[8]reported an average success rate of 86.2%(91.7% for renal stones less than 2㎝ in diameter) with piezoelectric lithotripter. Our experience with the Dornier MPL-9000 lithotripter showed a total mono-ESWL success rate of 98.1% and single one session success rate of 71.6 %.

Shock wave treatment with Dornier MPL-9000 lithotripter needed no anesthesia. In our experience intramuscular analgesics was necessary in only 16.6% of all sessions, and therapy was not stopped due to pain.

Complications of ESWL include flank or abdominal pain, chills, fever, oliguria, dysuria, gross hematuria, and Stone street. Eisenberger and associates reported pain or colic in 28 percent of all Dornier ESWL patients. Among them 50 percent were managed by application of oral antispasmodics and the remainder by intravenous injection of antispasmodics or narcotics. They also noted fever in 5 to 36 percent of the patients.

Lingemann and associates[9] reported complications in 17 patients after 982 treatments, including urosepsis in 3, pneumonitis in 1, myocardial infarction in 2, cardiovascular accidents in 3, ileus in 1, pancreatitis in 1, perirenal hematoma in 5 and pleural effusion in 1, Drach and associates also reported complications among 2475 treatments, including heart problems in 9 patients, anesthesia problems in 24, lung problems in 29, machine malfunction in 9, poor localization of stone in 8 and renal hematoma in 6.

Lingemann and associates[9] reported in more than 100 cases even if ESWL caused hypertension its effect was minimal. However Spinark and associates[10] 21 reported ESWL itself does not cause hypertension, a prospective controlled study is need between ESWL treated patients and patients treated by other methods.

In our ESWL treatment, sepsis, acute renal failure, renal hematoma, pulmonary or cardiac problems were not noted. The Stone street was occured on 24(15.5%) patients. Of these patients, 19 cases was passed spontaneously without intervention and 5 cases were treated with booster ESWL. Mild or colic pain occured after ESWL in 10 patients(6.4%) and they were managed by sedoanalgesics. Nausea occurred in 11 patients(7.0%) and fever was observed in 3 patients(1.9%) systolic blood pressure increased above 180㎜Hg after ESWL treatment.

In conclusion, Dornier MPL-9000 lithotripsy requires no anesthesia has higher success rate and causes fewer complication. Thus, ESWL monotherapy with the new Dornier MPL-9000 lithotripter is believed to constitute the initial applicable method for treatment of calculi regardless of size and location.

REFERENCES

1. Chaussy, C., Schmiedt, E Jocham, D., Brendel. W., Forssmann. b. and Walther, V. : First clinical experience with extracorporeally induced destruction of kidney stones by shock waves. J. Urol., 127 : 417 420, 1982
2. Clayman, R. V. and McClennan, B. L. : Lithostar : initial U.S.A. experience with electromagnetic extracorporeal shockwave lithotripsy. J. Urol., part2, 139 : 263A, abstract 401, 1988.
3. Drach, G, W., Dretler, S., Fair, W., Finlayson, B., Gillenwater, H., Griffith, K., Lingeman, J. and Newman, D. : Report of the United States cooperative study of extracorporeal shock wave lithotripsy. J. Urol., 135 : 1127, 1986.
4. Eisenberger, F., Fuchs, G., Miller, K., Bub, p. and Rassweiler, J. : Extracorporeal shock wave lithotripsy(ESWL) and endourology : an ideal combination for the treatment of kidney stones. World J. Urol., 3 : 41, 1985
5. Eisenberger. F., Fuchs, G, and Miller, K, : Extracorporeal shock wave lithotripsy and endourology : an ideal combination for the treatment of kidney stones. World J. Urol., 3 : 41, 1985.
6. Fetner, C.D., Preminger, G.M., Seger, J.A. and Lea, T.A. : Treatment of ureteral calculi by extracorporeal shock wave lithotripsy at a multi-use center. J.Urol. 139 : 1192-1194, 1988.
7. Kagnoski, R.J., Lingeman, J.E., Coury. T. A., Steele, R.E. and Mosbaugh. P.G. : Combined percutaneous and extracorporeal shock wave lithotripsy for staghorn calculi : an alternative to anatrophic nephrolithotomy. J. Urol., 135 : 679-681. 1986
8. Kim, S.C., Moon, Y.T. and Kim, K.D. : Extracorporeal shock wave lithotripsy mono therapy : experience with piezoelectric second generation lithotripor in 642 patients. J. Urol., 142 : 674 678, 1989.
9. Lingeman, J.E., Newman, D., Mertz, J.H. O., Mosbaugh, P.G., Steele, R.E., Kahnoski, R.J., Coury, T.A. and Woods. J.R. : Extracorporeal shock wave lithotripsy : the Methodist Hospital of Indiansa experience. J. Urol., 135 : 1134, 1986.
10. McDougall, E.M., Denstedt, J.D. and Clayman, R.V. : Lower pole percutaneous nephrolithotomy(PNL). Proceedings of the Fifth Symposium on Shock Wave Lithotripsy. Indianapolis. 1989.
11. Rassweiier. J., Bub, Pl, Seibold. J., Schmid A., Fehling. K., Jipp. P. and Esenberger, F., Dornier MPL-9000 : urologic use in an interdisciplinary stone center. J. Endourol, 2 : 57-61. 1988.
12. Rassweiler, J., Kohl, H., Gumpinger, R. and Mayer, R. : Wolf piezolith 2200 versus modified Dornier HM3 : range of indications, anesthesia and efficacy. J. Urol., part w, 139 : 263A, abstract 258, 1988.
13. Schulze, H., Hertle, L., Graff, J., Funke, P.J. and Senge, T. : Combined treat-

ment of branched calculi by percutaneous nephrolithotomy and extracorporeal shock wave lithotripsy. J. Urol., 135 : 1138, 1986

14. Singeman. J.E., Newman. D., Mertz. J. H.O., Mosbaugh. p.g., Steele, R.E., Kahnoski, R.J., Coury, T.A. and Woods, J.R. : Extracorporeal shock wave lithotripsy : the Methodist Hospital of Indiana experience. J.Urol., 135 : 1134, 1986.
15. Spirnak, J.P. and Resnick, M.I. : Extracorporeal shock wave lithotripsy. In urolithiasis. A medical and surgical references. edited by Resnick, M.I. and Pak. C.Y.C., Philadelphia : W.B.Saunders Co., Chapter 17.pp.321-361, 1990.
16. Vandeursen, H. and Baert, L. : Extracorporeal shock wave lithotripsy monotherapy for staghorn stones with the second generation lithotriptors. J. Urol., 143 : 252-256. 1990
17. Winfield. H.N., Clayman. R.V., Chaussy. C.G., Weyman. P.J., Fuchs. G.J. and Lupu A.N. : Monotherapy of staghorn renal calculi : comparative study between percutaneous.