

: CT

1

2 .

CT

10 Whipple

1 11

CT

가

5

75% 1 2 , 51 - 75%가 2 , 1 , 26 - 50%가 3 4 , 25% 4 2 , 5 2 . 175 mm² 69 mm² (p<0.05), 11 8 (73%) 50% 7.36 mm 4.81 mm (p<0.05).

3

가

, CT

가

endoscopic pancreatic sphincterotomy,

(1). 75 - 90% , (4, 9, 10). (pan - (pancreatic 가 , (1 - 3). 가 (4, 5, 9 - 13). (pancreatic duct stone) (extracorporeal shock wave lithotripsy) 가 (1, 2). 가 (10, 11). 1980 (1, 4 - 8). (14), (15) (16) . 1987 Sauerbruch (17) (

(4 - 9,

11 - 13).

2002 2002 11 1 2003 1 7 .

CT (endoscopic retrograde pancreatography) (Table 2).
(pancreas divisum)

1991 3 2001 3
11 10 Dormia
가 9 (main pancreatic duct)
10 1 1

, 1
Whipple
9 2 16-
74 (: 51)
9
2
0-60 (: 23)
7 4

. 2
, 1
(Table 1).

CT . CT GE 9800
(General Electric Medical Systems, Milwaukee, U.S.A.)
Somatom Plus (Siemens, Erlangen, Germany)
10 mm,
10 mm 10 mm
CT , 120 - 150 ml (Ultravist 300,
Schering AG, Berlin, Germany)
1 10
가 (side - viewing duodenoscope,
TJF - 200, Olympus Optical Co., Ltd., Tokyo, Japan)

Table 2. Types and Number of Endoscopic Interventions before and after ESWL

Patient No	Before ESWL		After ESWL	
	Pancreatic Sphincterotomy	Endoscopic Stone Extraction	Number of Endoscopic Interventions	Pancreatic Stent Insertion
1	+	+	2	-
2	+	+	1	-
3	+	+	1	+
4	+	+	2	-
5	+	+	1	-
6	+	Failed	Failed	-
7	+	+	1	-
8	-	-	0	-
9	+	+	2	+
10	+	+	1	-
11	+	+	1	-

Note: ESWL = Extracorporeal Shock Wave Lithotripsy

Table 1. Clinical Data of 11 Patients with Chronic Pancreatitis

Patient No	Age (yr)	Sex	Symptoms	Duration of Symptoms (months)	Etiology	Comment	Follow-Up Duration (months)
1	34	M	LUQ pain	36	Alcohol		60
2	64	M	- *	-	Alcohol	CBD stones	8
3	55	F	Epigastric pain	4	Unknown	GB, CBD stones	12
4	53	M	Epigastric pain	12	Alcohol		16
5	74	M	Epigastric pain	12	Unknown		14
6	16	F	Epigastric pain	60	Unknown		19
7	57	M	Epigastric pain	60	Alcohol	Basket impaction	3
8	71	M	RUQ pain	1	Alcohol	Whipple's operation	1
9	57	M	- *	-	Alcohol		0
10	46	M	Epigastric pain	5	Alcohol	CBD stricture	0
11	38	M	Epigastric pain	60	Unknown		0

Note: LUQ = left upper quadrant of abdomen, * Incidentally diagnosed, RUQ = right upper quadrant of abdomen, CBD = Common Bile Duct, GB = Gallbladder

5 - 10 mg 가
diazepam 가 1 - 60 (: 12)
(pulse oximetry) 가 CT
가 CT
1 2,000 가
1 (pancreatic body)
1 2 - 3 . 11
45 2 - 5
7 (: 4) (Table 3). 14kV 16kV , 1 75%
1 2,087 - 14,332 (: , 2 51 - 75%가 , 3 26 - 50%
7,707) , 1 1 1,044 - 가 , 4 25% , 5
2,307 (: 1,884)
가 1 CT , Paired *t* test (two tail test)
, *p* < 0.05

Table 3. Technical Data of ESWL

Patient No	Session Numbers	Total Shock Waves	Mean SW/Session
1	4	6,151	1,538
2	4	7,383	1,846
3	3	5,375	1,792
4	6	10,715	1,786
5	5	11,852	2,370
6	3	5,289	1,763
7	2	2,087	1,044
8	4	7,893	1,973
9	7	14,332	2,047
10	4	7,722	1,931
11	3	5,982	1,994
Mean	4	7,707	1,884

Note: ESWL = Extracorporeal Shock Wave Lithotripsy, SW = Shock Waves

CT
. 2 1 , 1
2 8
. 4 (pancre -
atic head) (neck) , 7
(Table 4).
, 1 2 , 2 1 ,
2 (18%)
9
175 mm² 69 mm²

Table 4. Results of ESWL by Comparing CT Findings before and after ESWL

Patient No	Before ESWL		Target Stone Size (mm)		Target Stone Area (mm ²)*		Ratio of Decrement (%)	Degree of Fragmentation	MPD Diameter (mm) [†]		Ratio of Decrement (%)	Recurred Stones
	Location of Stones	Number of Stones	Before	After	Before	After			Before	After		
1	All [‡]	Multiple	20 × 10	9 × 8	200	72	64	3	14	10	29	+
2	All [‡]	Multiple	19 × 15	17 × 14	285	238	16	1	5	4	20	
3	Head	Multiple	15 × 10	8 × 7	150	56	63	3	10	5	50	+
4	Head	1	19 × 10	10 × 10	190	100	47	2	4	2	50	+
5	Neck	1	18 × 15	9 × 8	270	72	73	3	5	5	0	
6	All [‡]	Multiple	12 × 7	2 × 2	84	4	95	4	12	3	75	
7	All [‡]	Multiple	17 × 10	13 × 10	170	130	24	1	10	10	0	
8	Head	2	11 × 6	2 × 2	66	4	94	4	8	7	13	
9	All [‡]	Multiple	20 × 10	- §	200	0	100	5	5	3	40	
10	Head, Tail	Multiple	17 × 9	- §	153	0	100	5	3	1	67	
11	All [‡]	Multiple	16 × 10	10 × 8	160	80	50	3	5	3	40	

Note: ESWL = Extracorporeal Shock Wave Lithotripsy, *Paired *t* test: *p* < 0.05, MPD = Main Pancreatic Duct, [†]Paired *t* test: *p* < 0.05,

[‡]All = All parts of main pancreatic duct, §Completely disappeared

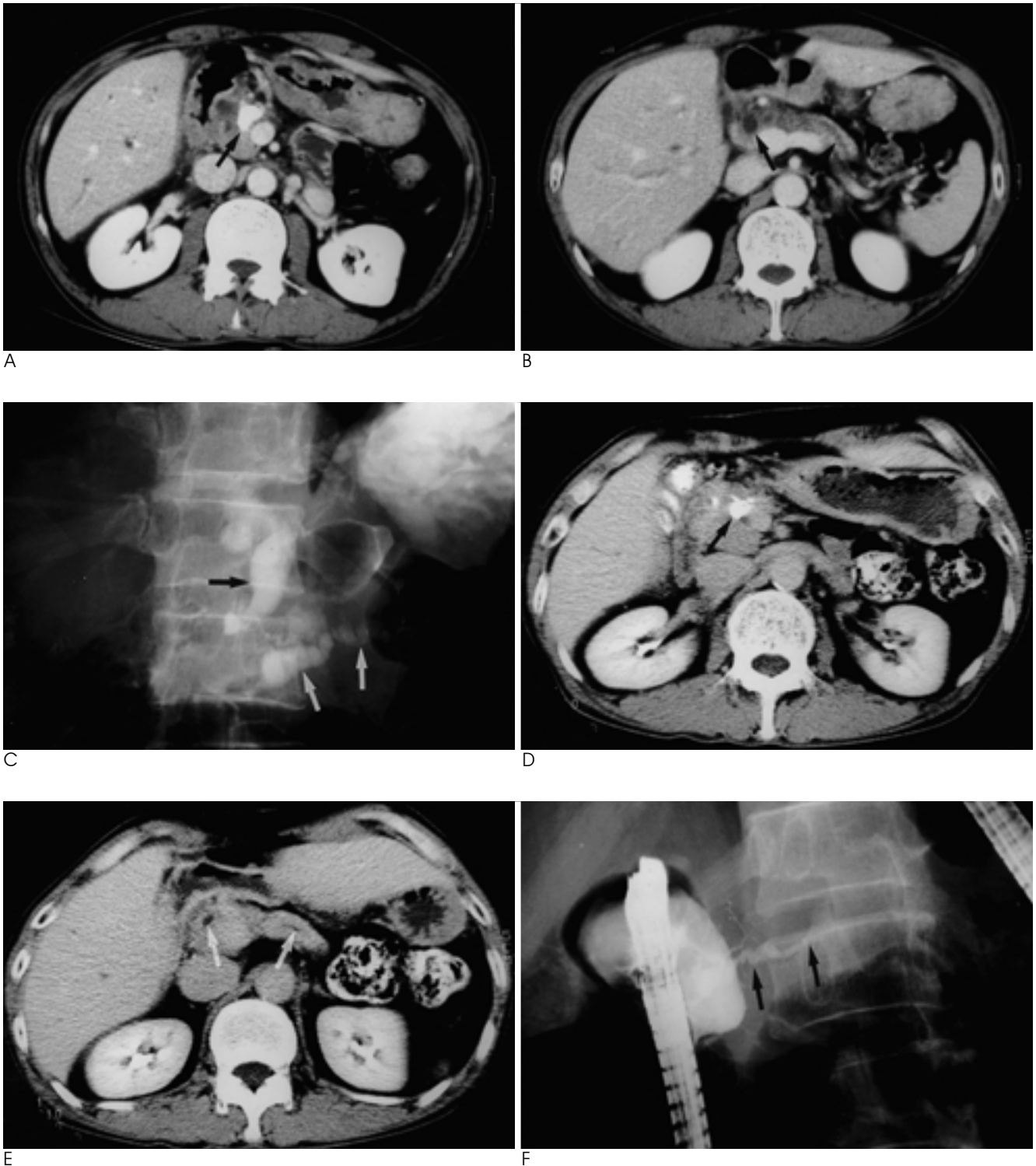


Fig. 1. 53-year-old man with epigastric pain for 1 year.

A. There is a large stone in the pancreatic head (arrow).

B. Main pancreatic duct is dilated at the body and tail (arrows).

C. Endoscopic retrograde pancreatography (ERP) shows irregularly dilated main pancreatic duct (white arrows) and common bile duct (black arrow).

D. After 6 sessions of ESWL, the stone in the pancreatic head decreased in diameter (arrow).

E. Main pancreatic duct diameter is also decreased (arrows).

F. ERP shows decompressed main pancreatic duct (arrows).

($p < 0.05$), 11 (5-7, 9, 11),
8 (73%) 50% 가 (9, 10,
7.36 mm 4.81 mm 12). Ohara (6)
가 ($p < 0.05$) (Fig. 1). 100% 75%
. 10
(Table 2). 9 1-2
, 3 (4, 9).
6 50-82%
. 1 가 (5, 6,
. Whipple 11).
. 2 (4, 5, 7, 11,
. Dormia 1 12).
. (3, 4, 10, 13).
. 2
11 5 amy -
lase/lipase 가 4 10
가 가 . Amylase/lipase 가 1 가
6 4 가 가
2 가 8 amylase/lipase가
가 . 1
가 3 7 3 (4, 10)
2 1 2 - (pancre -
aticobiliary fistula) . 1 가
60 (1, 6, 11).
(patient 1), 1 8
Whipple 가
(patient 2). (7).
0-25%
4 (4, 7, 10). 3
3-5 7 3
(10),
(5). 가 (10), 가
가 가
77-100% 38-75% Dormia
(nasopancreatic tube)
(8).

(9),

가 (5 - 7,

11). 0 - 27% amylase가 (4,

7). , CT 가

(9).

(6, 17),

(12). 8

가 가

. 1 가

(pancreaticojejunus - (8 - 10).

65 - 80%

, 20 - 40% 0 - 5%

5 30 - 50% 20%

(4, 6, 8, 10). -

(9, 18).

(5 - 7, 9 - 13).

가

가

가

(4, 6 - 9, 11, 17)

가 (1, 10),

가

CT

1. Ammann RW, Muench R, Otto R, Buehler H, Freiburghaus AU, Siegenthaler W. Evolution and regression of pancreatic calcification in chronic pancreatitis. A prospective long-term study of 107 patients. *Gastroenterology* 1988;95:1018-1028
2. Sarles H, Bernard JP, Gullo L. Pathogenesis of chronic pancreatitis. *Gut* 1990;31:629-632
3. Widdison AL, Alvarez C, Karanjia ND, Reber HA. Experimental evidence of beneficial effects of ductal decompression in chronic pancreatitis. *Endoscopy* 1991;23:151-154
4. Smits ME, Rauws EA, Tytgat GN, Huibregtse K. Endoscopic treatment of pancreatic stones in patients with chronic pancreatitis. *Gastrointest Endosc* 1996;43:556-560
5. Sauerbruch T, Holl J, Sackmann M, Paumgartner G. Extracorporeal lithotripsy of pancreatic stones in patients with chronic pancreatitis and pain: a prospective follow up study. *Gut* 1992;33:969-972
6. Ohara H, Hoshino M, Hayakawa T, et al. Single application extracorporeal shock wave lithotripsy is the first choice for patients with pancreatic duct stones. *Am J Gastroenterol* 1996;91:1388-1394
7. Delhaye M, Vandermeeren A, Baize M, Cremer M. Extracorporeal shock-wave lithotripsy of pancreatic calculi. *Gastroenterology* 1992;102:610-620
8. Schreiber F, Gurakuqi GC, Pristautz H, Trauner M, Schnedl W. Sonographically-guided extracorporeal shockwave lithotripsy for pancreatic stones in patients with chronic pancreatitis. *J Gastroenterol Hepatol* 1996;11:247-251
9. Costamagna G, Gabbrielli A, Mutignani M, et al. Extracorporeal shock wave lithotripsy of pancreatic stones in chronic pancreatitis: immediate and medium-term results. *Gastrointest Endosc* 1997;46: 231-236
10. Neuhaus H. Fragmentation of pancreatic stones by extracorporeal shock wave lithotripsy. *Endoscopy* 1991;23:161-165
11. Schneider HT, May A, Benninger J, et al. Piezoelectric shock wave lithotripsy of pancreatic duct stones. *Am J Gastroenterol* 1994;89: 2042-2048
12. Wolf JS Jr, Nakada SY, Aliperti G, Edmundowicz SA, Clayman RV. Washington University experience with extracorporeal shock-wave lithotripsy of pancreatic duct calculi. *Urology* 1995;46:638-642
13. Sauerbruch T, Holl J, Sackmann M, Paumgartner G. Extracorporeal shock wave lithotripsy of pancreatic stones. *Gut* 1989;30:1406-1411
14. Chaussy C, Brendel W, Schmiedt E. Extracorporeally induced destruction of kidney stones by shock waves. *Lancet* 1980;2:1265-1268
15. Sauerbruch T, Delius M, Paumgartner G, et al. Fragmentation of gallstones by extracorporeal shock waves. *N Engl J Med* 1986;314: 818-822
16. Sauerbruch T, Stern M. Fragmentation of bile duct stones by extra-

- corporeal shock waves. A new approach to biliary calculi after failure of routine endoscopic measures. *Gastroenterology* 1989;96:146-152
17. Sauerbruch T, Holl J, Sackmann M, Werner R, Wotzka R, Paumgartner G. Disintegration of a pancreatic duct stone with extracorporeal shock waves in a patient with chronic pancreatitis. *Endoscopy* 1987;19:207-208
18. Malfertheiner P, Büchler M. Indications for endoscopic or surgical therapy in chronic pancreatitis. *Endoscopy* 1991;23:185-190

Extracorporeal Shock Wave Lithotripsy on Pancreatic Duct Stones in Patients with Chronic Pancreatitis: Evaluation of Therapeutic Results with CT¹

Yong-Suk Lee, M.D.², Moon-Gyu Lee, M.D.

¹Department of Radiology, Asan Medical Center, University of Ulsan College of Medicine

²Department of Radiology, Gunpo Medical Center, Wonkwang University College of Medicine

Purpose: To demonstrate by CT scanning the effect of extracorporeal shock wave lithotripsy (ESWL) on pancreatic duct stones in patients with chronic pancreatitis.

Materials and Methods: Pancreatic duct stones in 11 patients with chronic pancreatitis were subject to ESWL using an electrohydraulic lithotripter. Endoscopic stone removal using a basket had failed in ten patients, and in one, endoscopy was impossible due to a previous Whipple's operation. CT scans obtained before and after ESWL were evaluated by two radiologists: the longest and shortest diameters of the target stone were measured, and according to the degree of fragmentation, determined by comparing the area of the stone before and after ESWL, a grade (1 - 5) was assigned. In each case, the pre- and post- treatment diameter of the main pancreatic duct, measured at the pancreatic body, was also compared.

Results: Disintegration of the target stone was achieved in all patients: grade 1 (over 75% of the area remained, compared with that of the initial stone) was assigned in two patients; grade 2 (51 - 75% of the original area) in one; grade 3 (26 - 50%) in four; grade 4 (under 25%) in two; and grade 5 (complete clearance of the target stone) in two. The mean area decreased from 175 mm² to 69 mm² after ESWL ($p < 0.05$); a decrease of more than 50% was observed in eight patients (73%). The mean diameter of the main pancreatic duct decreased from 7.36 to 4.81 mm ($p < 0.05$). No severe adverse effects or complications were noted, and all patients showed clinical improvement. Follow-up studies indicated that pancreatic duct stones recurred in three patients.

Conclusion: ESWL can cause the fragmentation of pancreatic duct stones without significant complications, and should be considered where endoscopic stone removal has failed. CT is a suitable non-invasive and accurate tool for evaluating the therapeutic results of ESWL.

Index words : Extracorporeal shock waves
Pancreas, CT
Pancreatic calcification
Pancreatitis

Address reprint requests to : Yong-Suk Lee, M.D., Department of Radiology, Gunpo Medical Center, Wonkwang University College of Medicine
1126-1, Sanbon-dong, Gunpo City, Gyunggi-do 435-040, Korea
Tel. 82-31-390-2598 Fax. 82-31-390-2584 E-mail: radlys@hanafos.com