

가 ()¹

.² .² .² .³ .³

: 가 (high - intensity focused ultrasound system, HIFU,)
: 가 18 19

MRI

: 4 cm .
가 89% . 2 MRI 79%
가 . 89%
, 10
가 가 12 24 , 가
6 가
: 가 ,

5)
(1), 80% (8 - 10). 0.8 - 3.5
가 , , MHz (: 1 - 20 MHz)가 , 0.8
3 - 6 (2). 6 - 10 , 가 MHz가 (8).
80

가 (heating effect) 가
(compression)
(radiofrequency ablation), (laser (rarefaction)
ablation), (cryotherapy), (microwave (acoustic cavitation)
therapy) (3 - 7) , (8).
(high - intensity focused ultrasound, HIFU,) 2005 Wu (11) 8 가
(8 - 11).

(median survival time) 11.25 ,

(

, 가

¹가

²가

³가

: 가 ()

, 6
18 가

가

2

2006 1 16 2007 1 15 18 (MRI)
가

. 1 T1
6

. 가 score 3 ,
18 가 9 , 가 9 , 가 score 2,
63 (47 -70), 가 50% score 1 ,
가 가 가 50% score 0

CT MRI CA19-9
, CA19-9 3,888 U/mL
(13 -20,000 U/mL)
9 , 3
, 6

. 가
score 3,
score 2, 가
score 1 , 가
score 0 MRI

3 SPSS 9.0 (SPSS Inc, Chicago, IL, U.S.A.)
. 18 19 (Pearson) , p

< 0.01

high -intensity focused
ultrasound system(Chongqing Haifu; Chongqing Haifu,
Chongqing, China) , 120 mm , 135 mm
, 0.8 MHz

120 -240 MHz score 2, score 3,
가 score 0 가 score 1 ,

10

, 3

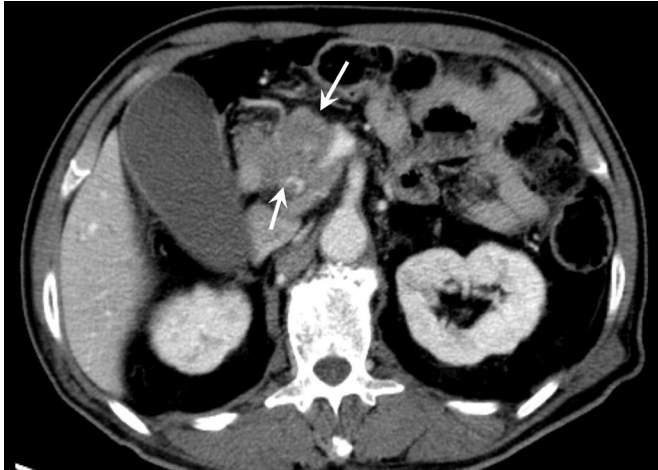
2

300 -500 mL 가

18 17 CT MRI . 2 MRI
1 가
2

46 (17) . 18
6 가 2-15 , 8 .

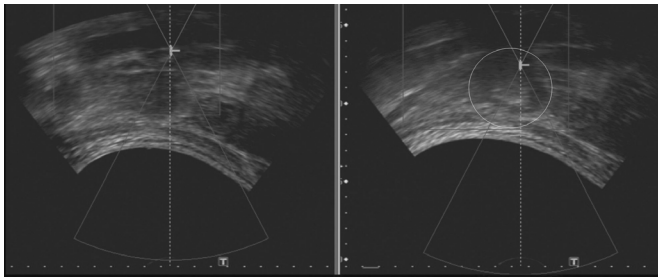
4 cm (2.5 cm - 7
cm) , 가 11 , 가 6 ,



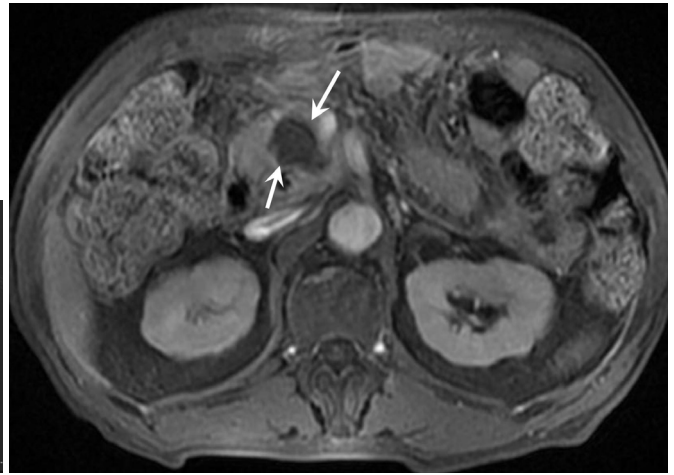
A



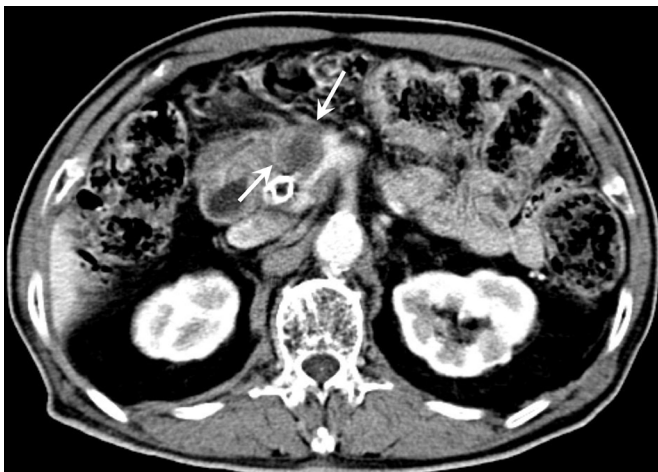
B



C



D



E

Fig. 1. A 80 year-old man with pancreatic head cancer.

A, B. Initial enhanced CT (**A**) and fat suppressed T1 weighted MR (**B**) images. There is an about 3.5 cm sized mass in the pancreatic head portion with invasion of adjacent vessel (arrows).

C. During HIFU treatment, the target area of the tumor was changed to echogenic focus on ultrasonography (white circle). Total anesthesia time was 175 minutes, total procedure time was 110 minutes and treatment time was 1599 sec.

D. Fat suppressed enhanced T1 weighted MR image after 2 weeks from HIFU treatment. Hypointense change of the mass is noted, suggesting necrosis of treated pancreatic cancer (arrows).

E. After 7 months from HIFU treatment, enhanced CT scan shows decreased size of the ablated tumor (arrows).

가 1 . 222 (3 42 , 145 (Fig. 1). 가
- 480) . 400 100% 가
50% 가 (Table 1).
195 (3 (Pearson)
(r) 0.709 ($p < 0.01$)
152 (2 32 , 84 - 245) ,
가 2346 (39 , 441 - 3958)
19 17
9 score 3, 8 score 2 . Score 3
2 1 1 1
15 score 3, 3
score 2 , 1 score 1 19 15 (79%)
가 , (89%)
가
Score 0
2 , score 1 2 , score 2 가 3 , score 3 12 ,
가 2 1 가, 1 3
50% 가 가 가 . 2 가 3
2 50% 가 가 가 . 3
3 1 50% 가, (amylase) (lipase)가
2 100% 가 , 가 가 ,
100% . 2 3
4 - 29 9 , 6 ,
4 . 10 가
2 MRI 가 . 2
10

Table 1. Extent of Coagulative Necrosis according to Gray-scale Change on Ultrasonography

		Volume of necrotic portion			Total
		score1	score2	score3	
Gray Scale	score0	1	0	1	2
	score1	0	2	0	2
	score2	0	1	2	3
	score3	0	0	12	12
Total		1	3	15	19

Table 2. Survival of Patients during Follow-up Examination

Case No	age	Sex	Follow-up period (weeks)	Survival	Remark	Follow-up imaging finding
1	71	F	23	Dead	Progression of peritoneal metastasis	Increase of tumor size (from 2.5 cm to 4 cm)
2	51	F	46		During Chemotherapy	No change of tumor size (4 cm)
3	80	M	42		During chemotherapy	Decrease of tumor size (from 3.6 cm to 2.2 cm)
4	55	M	27	Dead	Progression of liver metastasis	No change of tumor size (3 cm)
5	57	M	31	Dead	Progression of peritoneal metastasis	No change of tumor size (3 cm)
6	52	M	21	Dead	Progression of liver and peritoneal metastasis	Increase of tumor size (from 7 cm to 9 cm)
7	72	M	22		During chemotherapy	No change of tumor size (4 cm)
8	71	M	11		During chemotherapy	Increase of primary tumor size (from 4 cm to 4.4 cm)
9	67	F	6	Dead	Heart failure	No follow-up MRI
10	74	M	3	Dead	Sepsis	No follow-up MRI
11	62	F	10		Supportive care, progression of primary tumor	Increase of primary tumor size (3 cm)
12	61	F	9		During chemotherapy, development of liver metastasis during follow up	Decrease of tumor size (from 5.5 cm to 1.6 cm)

24 (9 - 46) ,
가 4 4

가

2 (Fig. 2). 10 5
가

가 12

Table 2

12 4

21 - 31

, 1

가

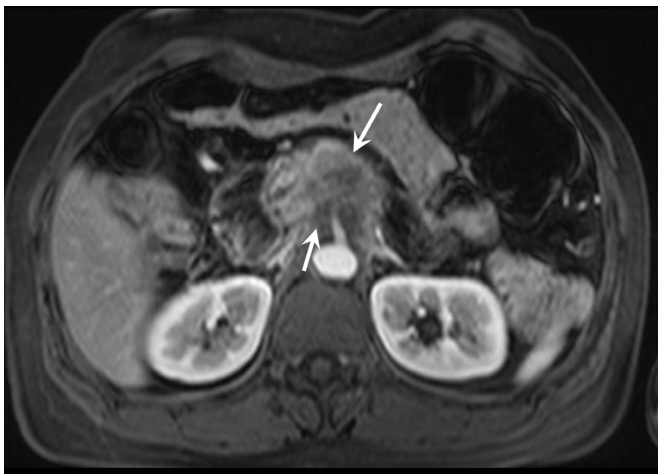
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, 6 가

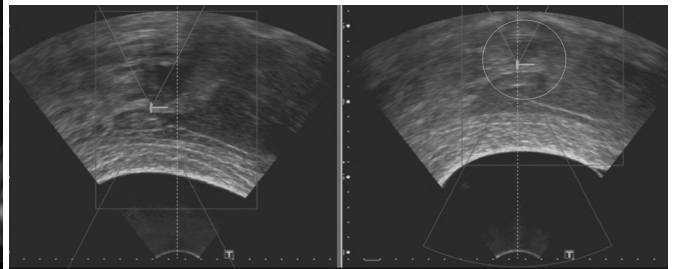
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가 (12).

(11).



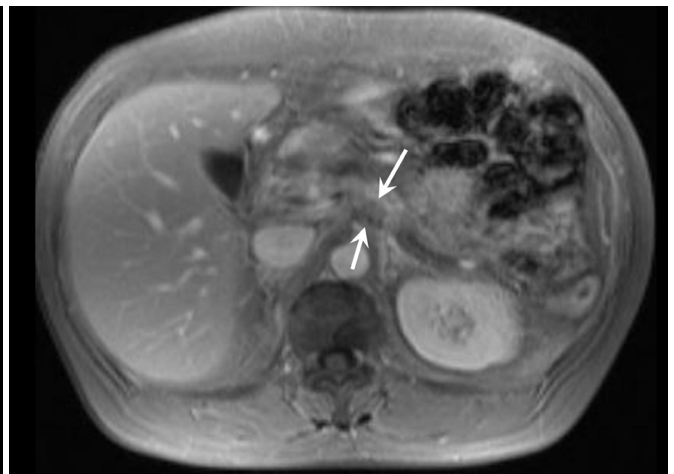
A



B



C



D

Fig. 2. A 51 year-old-woman with pancreatic body cancer

A. Before HIFU treatment, fat suppressed enhanced T1 weighted MR image shows an about 3 cm sized low signal intensity mass in the pancreatic body portion with invasion of adjacent vessel (arrows).

B. There is hyperechoic change of target tumor on ultrasonography during the HIFU treatment (white circle). Total anesthesia time was 275 minutes, total procedure time was 170 minutes and treatment time was 3067 sec.

C. 2 weeks after HIFU treatment, fat suppressed enhanced T1 weighted MR image shows clear coagulative necrosis in the target area (arrows).

D. 3 months after HIFU treatment, fat suppressed enhanced T1 weighted MR image shows decreased size of the treated mass in the pancreatic body from 3 cm to 1.5 cm (arrows).

[illegible]

- 2005;92:1825-1829
5. Varshney S, Sewkani A, Sharma S, Kapoor S, Naik S, Sharma A, et al. Radiofrequency ablation of unresectable pancreatic carcinoma: feasibility, efficacy and safety. *JOP* 2006;7:74-78
 6. Nikfarjam M, Christophi C. Interstitial laser thermotherapy for liver tumours. *Br J Surg* 2003;90:1033-1047
 7. Sotsky TK, Ravikumar TS. Cryotherapy in the treatment of liver metastases from colorectal cancer. *Semin Oncol* 2002;29:183-191
 8. Kennedy JE. High-Intensity focused ultrasound in the treatment of solid tumours. *Nat Rev Cancer* 2005;5:321-327
 9. . 2006;49:707-716
 10. . HIFU: . *Dia Treat* 2007;7:2420-2424
 11. Wu F, Wang ZB, Zhu H, Chen WZ, Zou JZ, Bai J, et al. Feasibility of US-guided high-intensity focused ultrasound treatment in patient with advanced pancreatic cancer: Initial experience. *Radiology* 2005;236:1034-1040
 12. Jaskolka JD, Asch MR, Kachura JR, HO CS, Ossip M, Wong F, et al. Needle tract seeding after radiofrequency ablation of hepatic tumors. *J Vasc Interv Radiol* 2005;16:485-491
 13. Molinari M, Helton WS, Espat NJ. Palliative strategies for locally invanched unresectable and metastatic pancreatic cancer. *Surg Clin North Am* 2001;81:651-666
 14. Caraceni A, Weinstein SM. Classification of cancer pain syndromes. *Oncology* 2001;15:1627-1643
 15. Farrar JT, Portenoy RK. Neuropathic cancer pain: the role of adjuvant analgesics. *Oncology* 2001;15:1435-1445
 16. Marineo G. Untreatable pain resulting from abdominal cancer: new hope from biophysics? *JOP* 2003;4:1-10
 17. Polati E, Finco G, Gottin I, Bassi C, Pederzoli P, Ischia S. Prospective randomized double-blind trial of neurolytic celiac plexus block in patients with pancreatic cancer. *Br J Surg* 1998;85:199-201
 18. Lillemoe KD, Cameron JL, Kaufman HS, Yeo CJ, Pitt HA, Sauter PK. Chemical splanchnicectomy in patients with unresectable pancreatic cancer: a prospective randomized trial. *Ann Surg* 1993;217:447-455
 19. Ceha HM, van Tienhoven G, Gouma DJ, Veenhof CH, Schneider CJ, Rauws EA, et al. Feasibility and efficacy of high dose conformal radiotherapy for patient with locally advanced pancreatic carcinoma. *Cancer* 2000;89:2222-2229
 20. Andre T, Balosso J, Louvet C, Hannoun L, Houry S, Huguier M, et al. Combined radiotherapy and chemotherapy(cisplatin and 5-fluorouracil) as palliative treatment for localized unresectable or adjuvant treatment for resected pancreatic adenocarcinoma: results of feasibility study. *Int J Radiat Oncol Biol Phys* 2000;46:903-911
 21. Burris HA 3rd, Moore MJ, Andersen J, Green MR, Rothenberg ML, Modiano MR, et al. Improvements in survival and clinical benefit with gemcitabine as first-line therapy for patient with advanced pancreas cancer: a randomized trial. *J Clin Oncol* 1997;15:2403-2413
 22. Rothenberg ML, Moore MJ, Cripps MC, Andersen JS, Portenoy RK, Burris HA 3rd, et al. A phase II trial of gemcitabine in patient with 5-FU-refractory pancreas cancer. *Ann Oncol* 1996;7:347-353

High-intensity Focused Ultrasound Treatment (HIFU) for the Advanced Pancreatic Cancer¹

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Purpose: We wanted to evaluate the levels of effect and safety of high-intensity focused ultrasound ablation (HIFU) for treating patients with advanced pancreatic cancer.

Materials and Methods: Nineteen sessions of HIFU, with the patients under general anesthesia, were performed in 18 patients with advanced pancreatic cancer. The change of the gray-scale of the target lesion was analyzed during HIFU, and MRI was performed before and after HIFU. We assessed the extent of coagulative necrosis, the change of pain and the complications after HIFU. The change of tumor size and the survival of patients were also evaluated.

Results: The average size of tumor was 4 cm in diameter. Eighty nine percent of the target tumors showed increased echogenicity. On MRI, necrosis of the entire target tumor occurred in 79% of the patients. After treatment, effective pain relief was noted in 89% of the patients. There were no major complications. No size increase of the treated tumor was noted during 24 weeks of follow-up for 10 patients. Six patients among 12 patients who were available for follow-up are still alive and they are receiving chemotherapy. Six patients expired due to other disease or progression of metastasis.

Conclusion: HIFU is a safe method without any major complications, and it is effective for inducing tumor necrosis and achieving pain control for patients with advanced pancreatic cancer.

Index words : Pancreas, neoplasms
Interventional procedures
Neoplasms, therapeutic radiology
Ultrasound (US), therapeutic
Therapeutic radiology

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