



가 VX2

:

1

: 가

VX2

가

: 가

30

VX2

: VX2

15 ,

8

6

8 가

, 9 , 14 가

가

: 가

VX2

150  $\mu$ m

(2-4)

(1).

가

(5-9).

(10)

가

1999

1999

BK21

2001 3 9

2001 11 27

: 가 VX2

(11, 12).

1968 Gra-miak Shah (13) SH U 508 A (Levovist; Schering, Berlin, Germany)  
가 480 mg 2 ml 240 mg/dl 2 ml  
(14-16). 가  
가 가  
2 ml 가 2 ml  
(17, 18). 가 2 ml  
VX2 0 60 5  
(microbubble) 가 120 10 , 180 20  
VX2 가 가  
(19-20) VX2 가 가  
가 5 cm 20 G  
VX2 가 가  
Ultravist 370 [iopromide] (Schering,  
Berlin, Germany) 4 cc  
(MK-IV, Medrad, Pittsburgh, Pa) 1 cc 4  
FOV  
가 가  
2 Kg 가 (New Zealand white rabbit) 30 3  
. VX2 가  
14-21 가 pentothal sodium ( 50  
calcium and magnesium - free Hanks ' balanced salt mg/Kg )  
solution (Grand Island Biological Co., Grand Island, NY)  
가 가 1 mm<sup>3</sup> 가 70 °C  
가 1 ml 72 가  
tuberculin 0.5 ml 18-G  
2-3 5 mm  
가  
ketamine hydrochloride 10% 3  
(Ketalar; Yuhan Yanghang, Seoul, Korea) 10 mg/Kg  
xylazine hydrochloride (Rompun; Bayer Korea, Seoul, Korea) 50 mg/Kg  
22-gauge (embedding) 6 μm  
hematoxylin and eosin

HDI 3000 (Advanced 가  
Technology Laboratories, Bothell, Wash) 10 MHz lin- 가 3  
ear array transducer 가  
가 1/2 가  
가  
(pulse repetition frequency) 1000 , low ,  
(color sensitivity) high , (gain) 80

50%가 3, 10% - 25% 가 4, 25 - 50% 가 2, 10% 가 1, 50 - 75% 가 3, 75% - 100% 가 1, 50%

가 Adobe Photoshop 5.0 (Adobe, San Jose, U.S.A.)

Photoshop 5.0 pixel (Wilcoxon signed rank test) pixel (Kruskall - Wallis )

PACS (Picture Archiving and Communicating System) (Spearman )

VX2 2 가 30 가 VX2 1.3 - 5 cm ( 2.95 ± 0.97 ) 11 , 17 , 2 9 , 15 , 6 0 10 , 1 20 0 7 , 1 5 , 2 12 , 3 6 (p<0.05) (Table 1).

PACS JPEG Adobe Photoshop 5.0 (Adobe, San Jose, U.S.A.) Photoshop 5.0 pixel pixel pixel 가 8 가 , 14 가 8

25% 0, 25 - 50% 1, 50 - 75% 2, 75% (fibrovascular stro - ma) 가 25 - 50% 3, 10 - 25% 2, 10% 1,

**Table 1.** The Grade and % Area of Tumor Vascularity in Conventional and Enhanced Power Doppler Sonography and DSA

	Grade of tumor vascularity					% area of tumor vascularity
	0	1	2	3	4	
PD	10	20				2.57 ± 2.88
CE-PD	7	5	12	6		10.16 ± 10.14
DSA	3	4	11	6	6	27.1 ± 20.27

PD=conventional power Doppler sonography  
CE-PD=contrast enhanced power Doppler sonography

3 6, 4 6 0 3, 1 4, 2 11, 가 가  
 (Table 1) (Table 1).  
 27.1%

15 0 5, 1 3, 2 7, 3  
 9, 3 7 0 6, 1 8, 2 8  
 7, 2 13, 3 8 (Table 2).  
 가

: 가 VX2 가  
 (Fig. 2).

(Fig. 3).

**Table 2.** The Grade of Necrosis, Development of Capsule and Fibrovascular Stroma in the Pathologic Examination

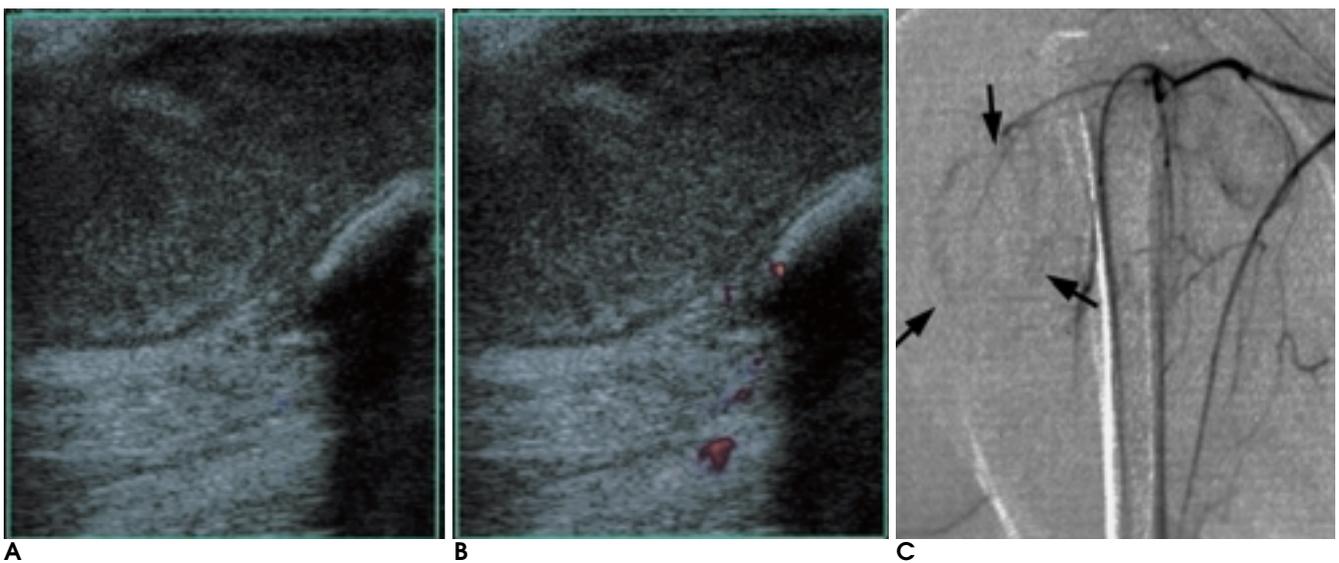
	Grade of pathologic findings			
	0	1	2	3
Necrosis	5	3	7	15
Capsule	6	8	9	7
Stroma	2	7	13	8

Stroma = fibrovascular stroma

(Fig. 1).

가

가

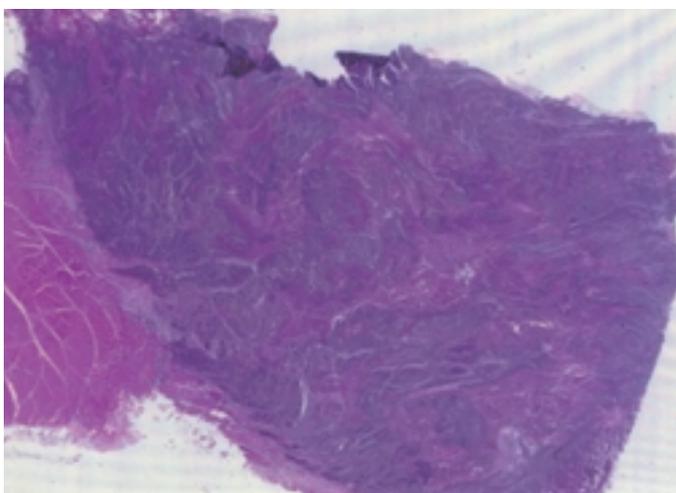


**Fig. 1.** Avascular type VX2 carcinoma on conventional and enhanced power Doppler sonographies and DSA.

**A, B.** Conventional and enhanced power Doppler sonographies show no Doppler signal within the tumor.

**C.** DSA demonstrates few tumor stainings in the tumor (black arrows).

**D.** Microscopic photography (hematoxylin and eosin staining, original magnification,  $\times 2$  (D)) of the tumor shows extensive necrosis (more than 75% of tumor area). There is poor development of fibrovascular stroma in the viable portion.



D

12  
4 ,  
6 , 2 .  
10  
가 6 ,  
가 4 .  
0.547  
(Table 3).  
0.476

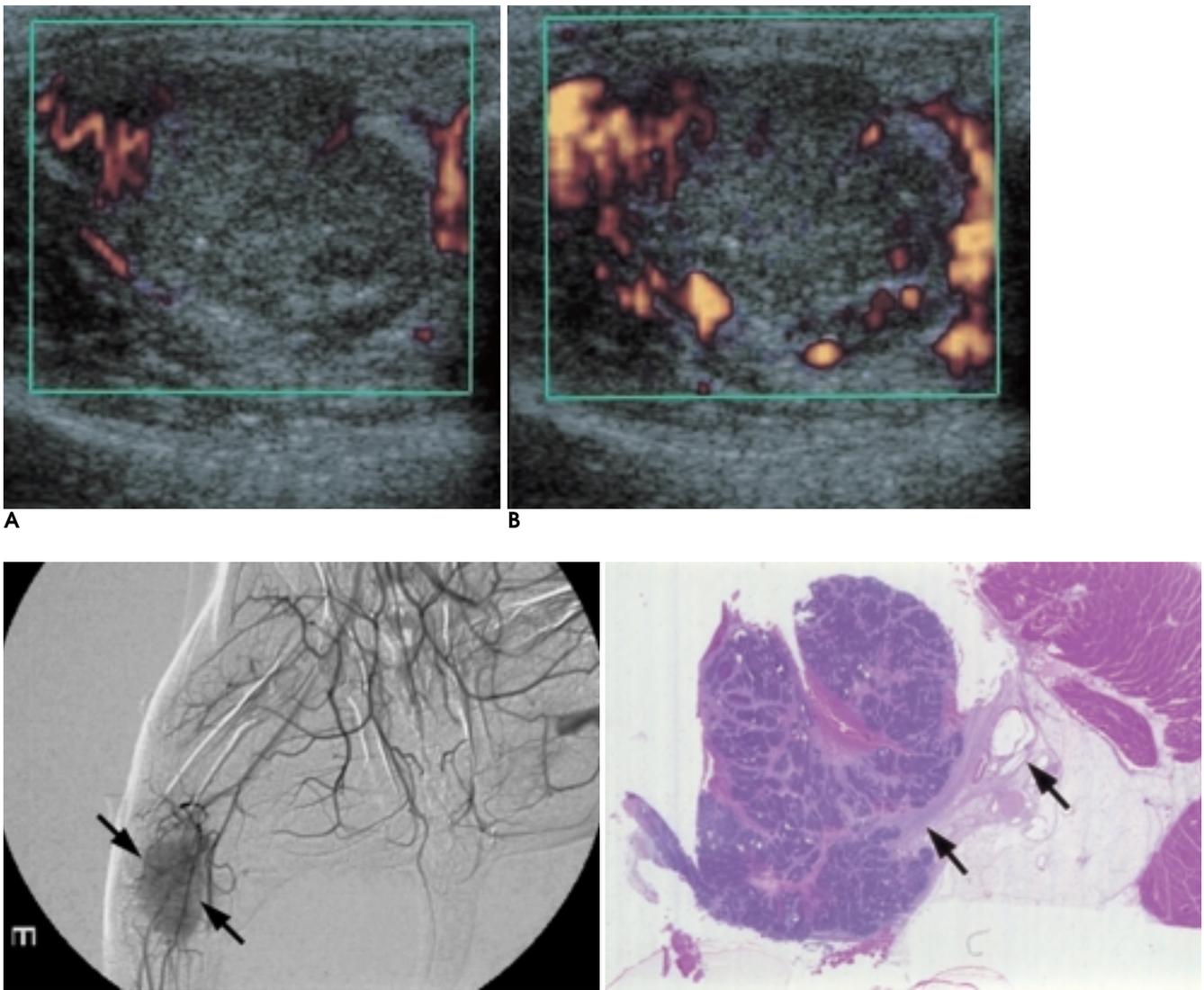
( $p < 0.05$ )

( $p < 0.05$ ),  
0.425  
( $p < 0.05$ ).

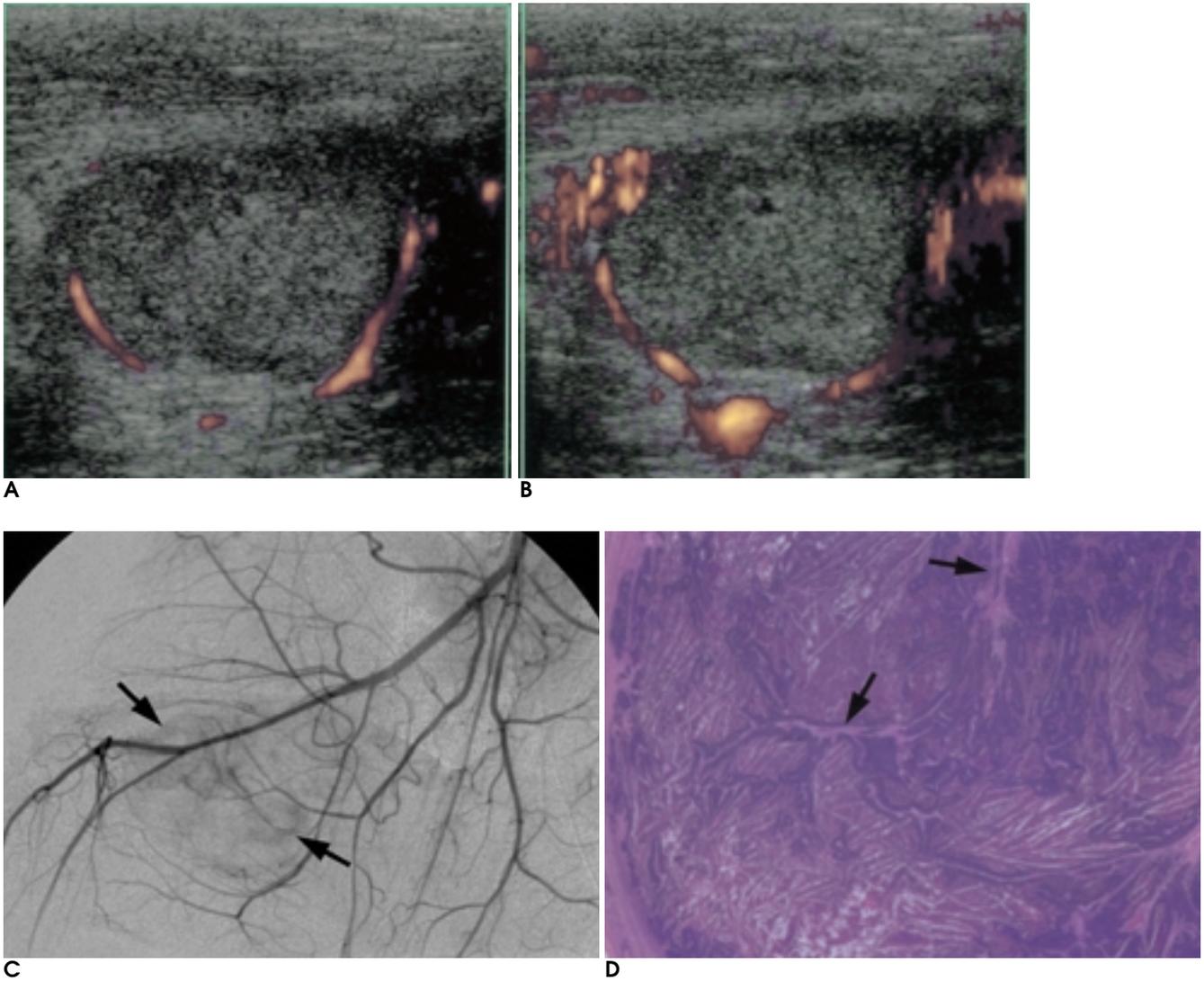
**Table 3.** Pattern of Tumor Vascularity in Enhanced Power Doppler Sonography and DSA

Tumor vascularity pattern at DSA	Tumor vascularity pattern at CE-PD			
	avascular	peripheral	diffuse	Total
avascular	5	3	0	8
peripheral	4	6	2	12
diffuse	0	6	4	10
Total	9	15	6	30

CE-PD = contrast enhanced power Doppler sonography



**Fig. 2.** Diffuse type VX2 carcinoma on conventional and enhanced power Doppler sonographies and DSA.  
**A.** Conventional power Doppler sonography shows peripheral Doppler signals in the tumor.  
**B.** Enhanced power Doppler sonography shows markedly increased peripheral and central Doppler signals in the tumor.  
**C.** DSA shows diffuse and homogeneous tumor staining and fine tumor vessels in the tumor (black arrows).  
**D.** Microscopic photography (hematoxylin and eosin staining, original magnification,  $\times 2$ ) shows little necrosis with compact aggregation of viable tumor cell. There are prominent fibrovascular stroma and capsule (black arrows).



**Fig. 3.** Peripheral type VX2 carcinoma on conventional and enhanced power Doppler sonographies and DSA.  
**A.** Conventional power Doppler sonography shows peripheral Doppler signals in the tumor.  
**B.** Enhanced power Doppler sonography shows increased peripheral Doppler signals in the tumor.  
**C.** DSA demonstrates peripheral tumor staining and tumor vessels in the tumor (black arrows).  
**D.** Microscopic photograph (hematoxylin and eosin staining, original magnification,  $\times 2$ ) shows moderate degree of tumor necrosis (about 50% of tumor area) and some fibrovascular stroma (black arrows).

**Table 4.** Correlation of Grade of Tumor Necrosis with Tumor Vascularity Patterns at Enhanced Power Doppler Sonography

Grade of tumor necrosis	Tumor vascularity pattern at CE-PD		
	avascular	peripheral	diffuse
0	0	4	1
1	1	1	1
2	0	5	2
3	8	5	2

CE-PD = contrast enhanced power Doppler sonograph

**Table 5.** Correlation of Grade of Fibrovascular Stroma with Tumor Vascularity Pattern at CE-PD

Grade of stroma	Tumor vascularity pattern at CE-PD		
	avascular	peripheral	diffuse
0	1	1	0
1	4	3	0
2	2	9	2
3	2	2	4

CE-PD = contrast enhanced power Doppler sonography  
 stroma = fibrovascular stroma

0.303,

0.325  
( $p > 0.05$ ).

가

가

(21).

가

( $p < 0.05$ ).

9

1 1 , 3 8

15 0 4 , 1 1 , 2가 5 , 3 5

6 0 1

1 2, 3 2

(Table 4).

9 0 1 , 1 4 , 2가 2 ,

3 2 15

0 1 , 1 3 , 2가 9 , 3 2

6 0, 1

2가 2 , 3 4

( $p < 0.05$ ) (Table 5).

가

(22). SH U 508 A 99.9% galac-  
tose 0.1% palmitic acid  
galactose  
palmitic acid

galactose

10

가

$\mu\text{m}$

(22).

가

가 0-1

가 (33%)  
(Table 4, 5).

(backscattered echo)

가

ing

가

10 - 25 dB

backscatter -

( $p < 0.05$ ).

transcranial

(16, 18, 23, 24).

Levovist

100%

(23).

( $p < 0.05$ ).

VX2

가

VX2

가

가 가

(9, 18, 25, 26).

(sinusoidal)

가

가

가

가 VX2

가

14

28.6% 100%

가 (27).

VX2

VX2  
가 VX2

가

가 (21) 가

가

가

VX2

가

가

가

가

15 (50%)

가

15

가

가

가  
가 가

가

가

가

가

가

가  
가

가

가

(16)가

(microvessel count)

가

가  
VX2  
가

VX2

가

가

(19, 20, 26).

가

가  
26% 30%

가

가

VX2

VX2  
(19, 20)

가

가

가

가

가

가

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## Tumor Vascularity of Experimentally Induced VX2 Carcinoma in the Rabbit Thigh: Evaluation with Enhanced Power Doppler Sonography and DSA Correlated with Histopathologic Findings<sup>1</sup>

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**Purpose:** To describe findings of enhanced power Doppler sonography and DSA in experimentally induced VX2 carcinomas in rabbit thigh and to correlate the imaging findings with the histopathologic features.

**Materials and Methods:** A total of 30 VX2 carcinomas were implanted in rabbit thigh, and after conventional and enhanced power Doppler sonography and DSA, histopathologic examination was performed. Enhanced power Doppler sonography and DSA, were used to determine the distribution pattern of tumor vascularity; to assess its grade and the percentage of a tumor area occupied by vessels, conventional and enhanced power Doppler sonography, as well as DSA, were used. The grade of necrosis and the development of fibrovascular stroma and capsule were histopathologically determined. The findings of power Doppler sonography were compared with those of DSA and the imaging features were correlated with the histopathologic features.

**Results:** At enhanced power Doppler sonography, the signal was either avascular (n=9), peripheral (n=15) or diffuse (n=6), while at DSA, the corresponding totals were eight, fourteen and eight. There was statistically significant correlation between enhanced power Doppler sonography and DSA, both in their depiction of the distribution of patterns of tumor vascularity and as regards their findings of grade and percentage of vascular area. As determined by both conventional and enhanced power Doppler sonography, and by DSA, grade of necrosis and the development of fibrovascular stroma and a capsule correlated with grade and the percentage of vascular area.

**Conclusion:** Experimentally induced VX2 carcinomas in rabbit thigh demonstrated various patterns of tumor vascularity, and the findings of enhanced power Doppler sonography correlated with those of DSA. Tumor vascularity, as demonstrated by two imaging modalities, correlated closely with grade of necrosis and the development of fibrovascular stroma and a capsule, as revealed by histopathologic examination.

**Index words :** Neoplasms, experimental  
Neoplasms, blood supply  
Ultrasound (US), Doppler studies  
Angiography

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