

전이성 뇌종양에 대한 감마나이프 방사선수술 후 방사선괴사 발생에 관여하는 인자들

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Factors Related to Occurrence of Radiation Necrosis Following Gamma Knife Radiosurgery for Metastatic Brain Tumors

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ABSTRACT

Objective : Gamma Knife radiosurgery (GKS) has been used for treatment of metastatic brain tumors. Radiation necrosis is the most significant complication of GKS. Authors retrospectively reviewed the treatment parameters of GKS to determine if there were significant factors affecting the occurrence of radiation necrosis after GKS.

Materials : From 1992 to 2002, 171 GKS procedures for 572 metastatic brain lesions in 150 patients were included in this study. Total 10 lesions in 10 patients were diagnosed as radiation necrosis. Their treatment parameters were analysed and compared with control group.

Results : Of 10 patients with radiation necrosis after GKS, the primary sites were lung (7 patients), gastrointestinal tract (2 patients) and kidney (1 patient). Five patients had multiple brain lesions and the mean number of lesions were 2.6. Mean dose, maximal dose, integral dose, prescription isodose volume (PIV)/tumor volume (TV) and 10% normal brain volume showed significant difference between radiation necrosis group and non-radiation necrosis group. Patient's age, marginal dose, prescription isodose line, number of isocenter, marginal dose, PIV and tumor volume were not related to the occurrence of radiation necrosis.

Conclusion : For the treatment of metastatic brain tumors, radiosurgery has the advantage of whole brain radiation therapy. Because the radiation necrosis, which is the only serious complication of radiosurgery, is reversible condition, the goal of tumor control should not be affected by concern of this complication.

KEY WORDS : Gamma Knife radiosurgery · Radiation necrosis · Metastatic brain tumors.

서 론

3,8,9,12,17,18)

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가 가 ,
가
4

가 . (whole brain radiation therapy ; WBRT), (maximum dose, Gy), (marginal dose, Gy), (mean dose, Gy), prescription isodose line(%), 10Gy (10Gy normal brain volume, mm³), (tumor volume ; TV, mm³), (integral dose, mJ), isocenter , prescription isodose volume(PIV)/TV . Prescription isodose volume , 10Gy

가 , 3,8,9,12,13,17,18) . Cox 가

3,6,14) , 1~3 (months) . p 0.05

3,9,12,13,17,18)

대상 및 방법

1992 2002 가 150
572 171
1 MRI
, 1) MRI 가
, 2) MRI
, 2)
150 572 , 10 (6.7%)
10 (1.7%)
가 가
가 140 562
Cox proportional hazard
model

(whole brain radiation therapy ; WBRT)
(maximum dose, Gy),
(marginal dose, Gy), (mean
dose, Gy), prescription isodose line(%), 10Gy
(10Gy normal brain volume, mm³),
(tumor volume ; TV, mm³), (integral dose,
mJ), isocenter , prescription isodose volume(PIV)/
TV . Prescription isodose volume
, 10Gy

10Gy
. Cox 가

(months) . p 0.05
가

결 과

1. 환자 분포

150
가 89 , 가 61 ,
가 5 , 가 5
140
57.5 (17~79) ,
55.6 (37~70) , Karnofsky score 80
(70~90) . 150
가 85 (56.7%)
가 가 17 (11.3%), 14
(10%), 12 (8%)
18 (12%)
가 2 (1.9%)가 10
7 (70%), 2
(20%), 1 (10%)
가 5 , 가 5 ,
2.2 (1~7) . 11.2 (0.5~
61.1)
4
46

2. 치료 변수의 비교

가
Table
1 . , , ,

Table 1. Comparison of treatment parameters and statistical analyses between radiation necrosis and control group

Parameters	Median value(range)		p-value
	Radiation necrosis(10 lesions)	Control(562 lesions)	
Patient age(year-old)	55.6(37 - 70)	57.4(17 - 79)	N.S
Maximum dose(Gy)	36.8(29.5 - 38.0)	28.7(15 - 45)	<0.05
Prescription isodose(%)	52.2(50 - 60)	52.5(40 - 70)	N.S
Number of isocenter	5.8(1 - 14)	5.4(1 - 10)	N.S
Mean dose(Gy)	19.7(8.2 - 29.0)	15.4(7.5 - 37.4)	<0.05
Margin dose(Gy)	17.6(16.0 - 19.0)	16.8(8.0 - 27.5)	N.S
Tumor volume(cm ³)	14.3(2.8 - 47.4)	11.1(9.3 - 20.3)	N.S
Integral dose(mJ)	256.8(30.8 - 474.5)	114.9(2.3 - 416.0)	<0.05
PIV/TV (mean ± SE)	1.99 ± 0.52	1.22 ± 0.32	<0.05
10Gy normal brain volume (cm ³ , mean ± SE)	37.7 ± 5.0	30.0 ± 4.0	<0.05

PIV : prescription isodose volume, TV : tumor volume. N.S : not significant

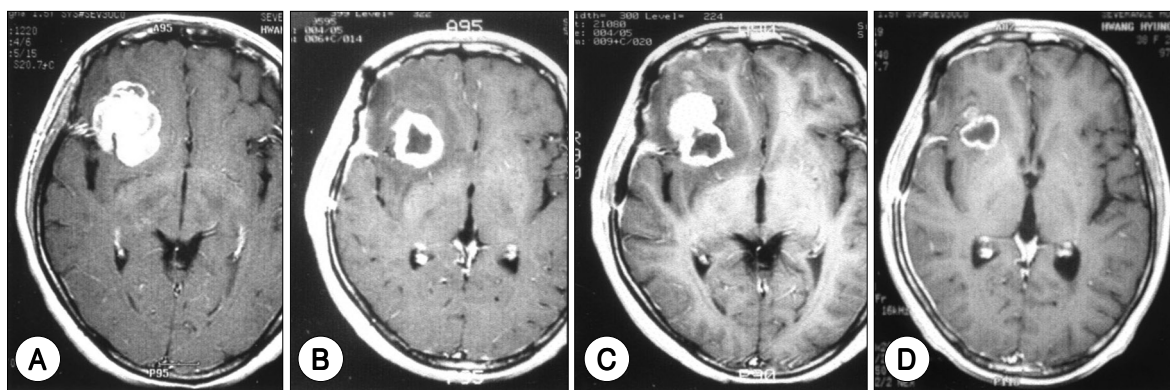


Fig. 1. Serial follow-up brain MRIs of a patient with metastatic brain tumors from lung cancer and typical temporal course of radiation necrosis. Pre-GKS MRI shows a solid metastatic brain lesion on right frontal area(A). MRI at 3 months after GKS shows decreased tumor size with central necrosis and perilesional low density(B). MRI at 5 months after GKS shows enlarged enhanced lesion and perilesional edema(C). MRI at 12 months after GKS shows resolution of perilesional low density and decreased size of enhanced portion(D). GKS : Gamma Knife radiosurgery.

PIV/TV, 10Gy

. 10 8

, prescription isodose line, isocenter
, PIV

(Fig. 1).

3. 방사선과사 환자의 진단 및 치료

8.6 , 10 5

, 3 , 2
가
(PET)
(SPECT)

가
가
MR spectroscopy,

가 PET MR spectroscopy
가
MR spectroscopy 2.0ppm N-acetyl
aspartate(NAA) peak가 choline peak lactate peak
choline peak
NAA peak가 lactate peak가 가
choline peak가 NAA peak 가
가 (Fig. 2). MR spectroscopy PET
PET

mannitol
. 10 2

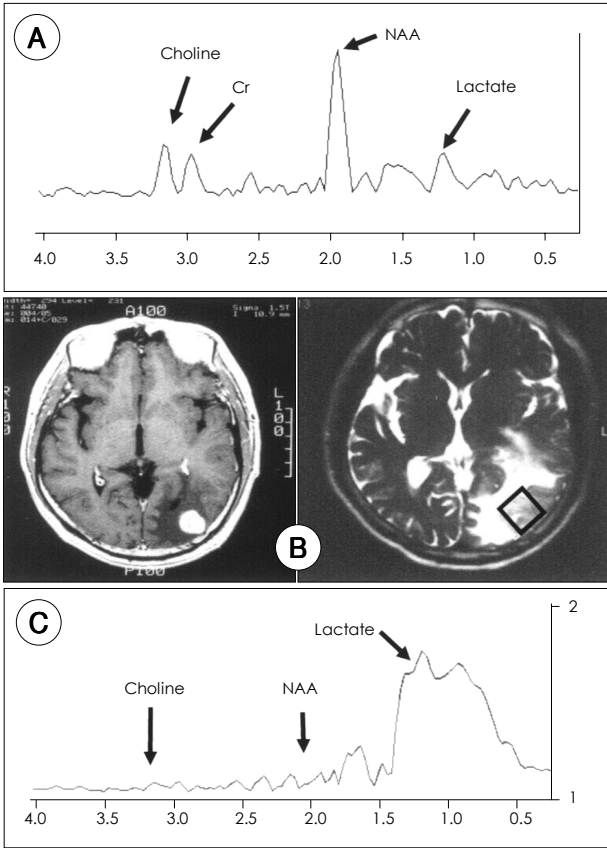


Fig. 2. Brain MRIs of a patient with radiation necrosis after Gamma Knife radiosurgery for metastatic brain tumor(B). Normal finding of MR Spectroscopy(A) showing Lactate peak at 1.3 ppm, N-acetyl aspartate(NAA) peak at 2.0ppm, Cr peak at 3.0ppm, and Choline peak at 3.2ppm. MR spectroscopic finding of radiation necrosis(C) showing the elevated Lactate peak and the decreased choline and NAA peak.

고 찰

3,9,12,13,17,18) Young¹⁸⁾

가 90%

8~10

1)

가

40%, 30%, 20%

, 2)

3

(eloquent area)

MRI

MRI

가

3,8,9,12,13,17,18)

가 3~4

10~15

가

가 3~4cm

(mass effect)

3,12,17,18)

3가

가

1

1

1

3

3

3,7,14)

3,6,14)

Majhail⁷⁾

82

8

25mm

20Gy

4.4Gy

가

3)

가 1~5%

가 1~6%

3)

3,17,18)

가

2,17,18)

(5%), (7.5%)

(cell death)

: SF=exp(-

D - D²).¹⁾ SF (survival fraction), D (radiation dose) /

가

가

^{2,13)}

(fraction size)

/

²⁾

(fraction size)

PIV

가

, PIV/TV, 10Gy

²⁾

/

가

1

/

가

^{2,4)}

가

가

가

가

²⁾

가

가

MR spectroscopy

PET

^{11,13)} Nakamura ¹⁰⁾

PET MR spectroscopy

^{12,16)}

(prescription iso-dose volume ; PIV) , Chin

²⁾

결론

(tumor volume integral dose)

가 10Gy가

가

가

가

가

가

^{2,13)}

, PIV/TV, 10Gy

WBRT

가

17%

가

가

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