

21

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가
 3-dimensional conformal radiotherapy , linac based stereotactic radiosurgery
 intensity modulated radiation therapy (IMRT)
 20 4
 , IMRT , biological conformity ,

, 21
 1) QA (quality assurance) , 2) 3
 , 3) 가 , 4)
 data base care study
 Total No. of Centers : 54
 : 21

1998 20,227
 30% 1991 50% 가 ,¹⁾
 1/3 가 2010 3
 가 ,¹⁾ 50% 가 (Fig. 1),
 local control 가 2000 4 54 2-3
 가 (Fig. 2).
 (QOL: quality of life) (QOT: quality of treatment) 1968 1970 Beam's eye
 view planning 1980 CT-simulation
 (Table 1) 3D-CRT 가 ,
 가 3D-CRT 4 IMRT
 3-dimensional conformal radiotherapy (3D-CRT) 가 biological conformal RT
 , linac based stereotactic radiosurgery (SRS) QOL
 intensity modulated radiation therapy (IMRT) QOT 가 1988
^{2,3)} 가 ⁴⁾
 Linac-based SRS gamma-knife
 Linac-based SRS Green-knife가
 1994

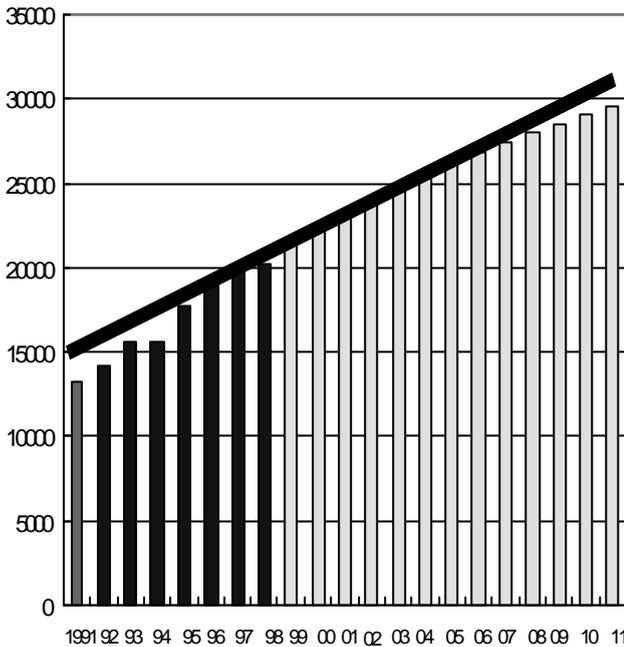


Fig.1. Figure shows the projected increase in number of new radiotherapy patients in Korea. The projected growth rate is 5% per year. The increase the number of new radiotherapy patients will be doubled in by the year 2010 compared with in 1991.

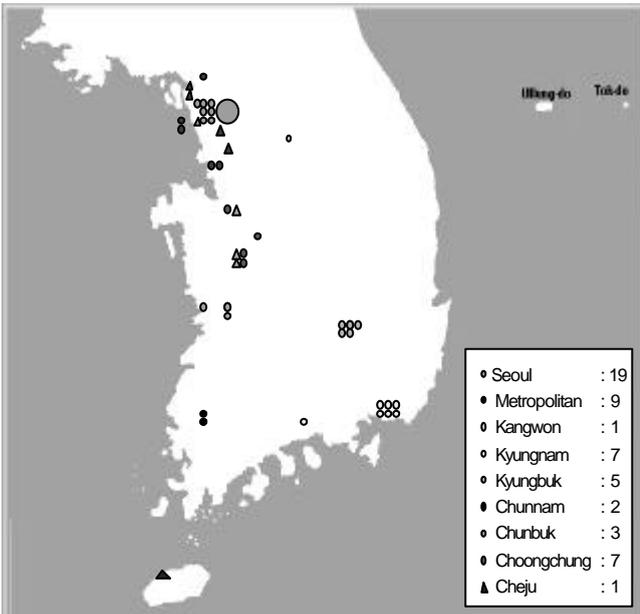


Fig. 2. The number of radiotherapy centers is 54 in Korea in April 2000, which shows rapid increase of treatment facilities since last year.

Table 1.

1968	Computerized Treatment planning
1970	Computerized Treatment planning
1978	Beam's eye view planning
1980	Beam's eye view planning
1987	CT-Sim
1990	3-D Conformal RT, CT-Sim
1996	IMRT (Nomos)
2000	IMRT, Biological conformal
1988	Linac Based planning
1990	Gamma Knife
1994	Green Knife(Linac based SRS)
1994	MLC, EPID, 3DRTP, 3D Conformal therapy
1995	CT Simulator, 3D Conformal RT
1995	FSRT
1994	image Chart (ROIS)
1997	
1999	
1999	telemedicine
2000	IMRT

SRS

radiation oncology information system (ROIS)

1994

ROIS

digital image

image data

data base

digital image chart

paperless, filmless

가

9)

telemedicine

()

Hokkaido

THERAPIS (telecommunication helped radiotherapy planning and information system)

Hokkaido

ISDN (integrated service digital

network)

가

10) 3D-CRT

gated radiotherapy (4-D

CRT)

IMRT

5) 1995 fractionated stereotactic radiosurgery (FSRT) . 1994 (multileaf collimator) EPID (electronic portal imaging device) 가 3D RITP 3D-CRT가 , 1997

가

가

가

가

가 가

3D-CRT

4-D RT

10 15

beamon

2

gated

2가

tumor-tracking

^{12,13)}

tumor-awating

Tumor-tracking

SRS, (FSRT),
(3D compensator-based treatment), IMRT

(multileaf collimator)가

가

3D-CRT

가

3D-CRT

65 70 Gy

3D-CRT

가

81 Gy

가

Tumor- awating

가

가

¹¹⁾

^{12,13)}

2가

25 Gy

가

X-

3D-CRT

60 Gy

,

가

가

conformation

가

^{12 15)}

4

가

real-time dynamic image radiotherapy planning

2 4 cm 가

가

가

Intensity modulated therapy (IMRT)

3가

IMRT

3-D CRT

가

가

가

IMRT

diaphragm compressor

. Diaphragm

(beamlet, segment)

compressor

Karolinska

3 Gy,

2.2 Gy

1.8 Gy

0.2 Gy

가

Physical conformality biological conformality

CT MRI

CT

MRI (Fig. 3).

SPECT (single photon emission computed tomography) PET (positron emission tomography) functional imaging

CT MRI

functional Image

3D-CRT

multi-dimensional radiotherapy (MD-CRT)

biological conformal

RT

biological functional image

FDG (Fluorodeoxy-glucose) PET SPECT, MRI MR

spectroscopy

metabolic data

image

Ling ²¹⁾

biological ²¹⁾

Biological image

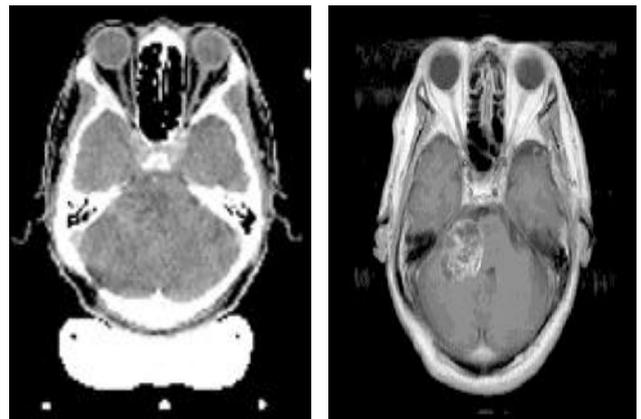


Fig. 3. Image fusion of MRI and CT in vestibular schwannoma for stereotactic radiosurgery in Samsung Medical Center.

¹⁶⁾ 3-D CRT 가 .

IMRT 가 ¹⁶⁾ 3 .

가 가 (Simultaneous Modulated Accelerated Radiation Therapy Boost, Simultaneous Integrated Boost, Concomitant Boost, Concurrent in-field boost, SMART) ¹⁵⁾ 가 가

SMART 가 가

가 (accelerated repopulation)

가 가

가

^{18,19)} IMRT 1990 ²⁰⁾ 가 가 (optimization)

(inverse planning)

, SMART , 3 (immobilization)

¹⁸⁾ IMRT

가 (stereotactic device) (electronic portal image device)

가 IMRT 가

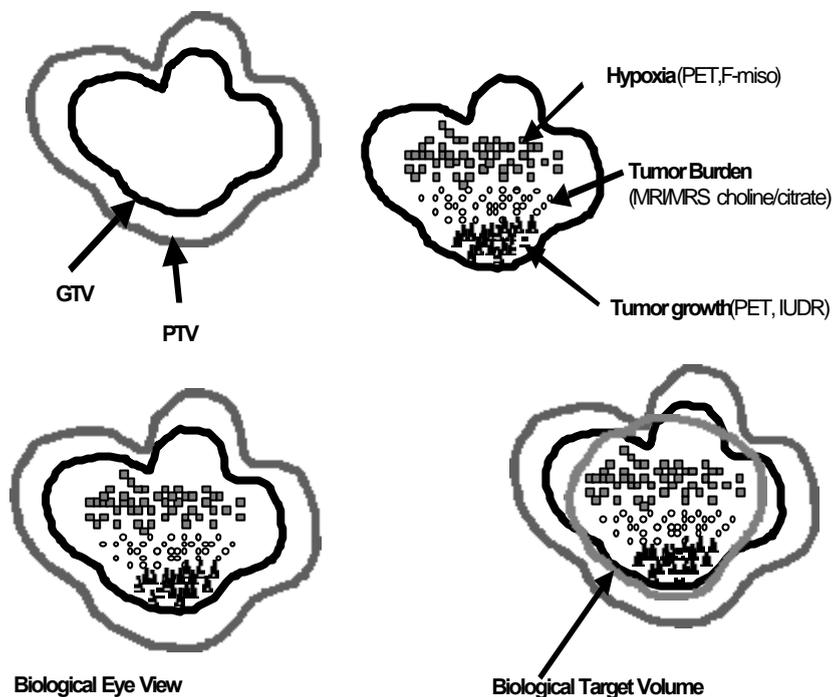


Fig. 4. A schematic illustrating the concept of biological target volume (BTV) modified from Ling.¹⁹⁾ Biological image provides information for defining the BTV.

(Fig. 4). Ling²¹⁾ biological image

“ultraconformal RT” 가
tumor volume

IMRT . Functional
MRI brain mapping critical
area . Nuclear magnetic resonance
(NMR) spectroscopy
choline level
가 University of California, San Francisco
(UCSF)²³⁾ 1H-NMR
choline/citrate ratio가
IMRT choline level
. FDG-PET 가²⁴⁾

fluorinated misonidasole-PET hypoxic region i maging
biological conformality . Inverse planning
IMRT physical tumor volume
dose homogeneity 가
tumor volume
“dose sculpting” biological target 44% 28%가³²⁾ 3
volume MD-CRT 가
^{21,25)}

Combined chemoradiotherapy
combined chemoradiotherapy (CCRT)
1999
CCRT
SWOG^{26 30)} GOG, RTOG,
가 IIB , CCRT
10%
가가 (Table 2).
NCI³¹⁾ NCI Clinical Announcement “Strong
consideration should be given to the incorporation of concurrent
cisplatin-based chemotherapy with radiation therapy in women who
require radiation therapy for treatment of cervical cancer”
CCRT 가 가
SWOG, RTOG, CALGB, NCCTG, ECOG
inter-group study 가
CCRT
CCRT
가

Table 2 Five Randomized Trials Demonstrating the Efficacy of Chemoradiotherapy for Cervical Cancer

Study	Stage	Control Group	Comparison Group	Survival
GOG #123 Key ²⁶⁾	IB-2	Radiotherapy	Radiotherapy plus Cisplatin (CDDP)	74% vs 83%
GOG #120 Rose ²⁷⁾	IIB-IVA	Radiotherapy Plus Hydroxyurea (HU)	Radiotherapy Plus CDDP or CDDP, 5-FU & HU	47% vs 65%
RTOG #9001 Morris ²⁸⁾	IB-2-IVA	Extended-field Radiotherapy	Radiotherapy plus CDDP & 5-FU	63% vs 75%
GOG #85 Whitney ²⁹⁾	IIB-IVA	Radiotherapy plus Hydroxyurea	Radiotherapy plus CDDP & 5-FU	57% vs 67%
Intergroup #107 Peters ³⁰⁾	IB-IIA Post-op	Radiotherapy	Radiotherapy plus CDDP & 5-FU	77% vs 87%

가

IT (information technology)

2.

(Radiation oncology

information system : ROIS)

1.

IT 가 21 가

가

가

가

³⁵⁾ Varis (Varian Oncology, Palo Alto, CA, USA)
Lantis (Siemens Medical Systems Inc., Concord, CA, USA)

30%

28%

2000 5

가 가 1) (Hospital information system: HIS) interface가 2)

가 3) interface가

10,000

4) 5)

가

ROIS

³³⁾

Botnick ³⁶⁾ ROIS 1) HIS
2) 3) financial database

가

가 4)

Lantis Varis

³⁴⁾

(Cyber Watcher)

HIS 가

가

가

ROIS가

가 가

ROIS

가

(C-ROMS : Comprehensive-Radiation Oncology Management System)

^{7 9)} HIS (Hospital Information System) 가

digital image chart system, , electronic radiotherapy record system 가 Varis Lantis 가 auto-setup interface가

**Image guided radiotherapy :
Robotic arm Linac, CT guided radiotherapy,
helical tomotherapy**

3 interface C-ROMS cyber knife 1992 Stanford Adler 38) setup record verify 가 pattern of care study database form

가 SRS . Cyber knife i mage based stereotactic radiotherapy robotic SRS/SRT 가 , gated radiotherapy가 가 SRS가 가 i mage target tracking

3. network (telemedicine)

Table 3 Features of a RT Telemedicine System

	Video Conference	Image display wide	Database replication, on	Real-time, remote
Level 1	+	+	-	-
Level 2	+	+	+	-
Level 3	+	+	+	+

1990 DICOM 10,37)

radiotherapy가 가 CT 1999 Rose 39) 가

Mayo , Hokkaido , Kyoto , QA , Hokkaido

CT CT CT CT Monte Carlo simulation Iodine 가 10 mg/g 10 MV X-ray 가 dose profile 5 Gy 45 가 simulation

Network data 가 37) DICOM DICOM-RT 가

Olsen 37) 3 MR CT i mage

가 CT Linac helical tomotherapy University of Wisconsin CT scanner megavoltage beam accelerator detector , simulation, setup, IMRT 20)

3 2 가 (Table 3). Hokkaido THERAPIS 2 가

21	3	4
IMRT	biological imaging	
biological conformality		
	1) QA	
	QA protocol	
	2)	
3	, 3)	가
, 4)	, 5)	
care study	data base , 6)	patterns of
Table 4	(Table 4). 가	
QA	QA	
		guide line
software		
patterns of care study	base	data

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Advances in Radiation Oncology in New Millennium in Korea

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The objective of recent radiation therapy is to improve the quality of treatment and the after-treatment quality of life. In Korea, sharing the same objective, significant advancement was made due to the gradual increase of patient number and rapid increase of treatment facilities. The advancement includes generalization of three-dimensional conformal radiotherapy (3D-CRT), application of linac-based stereotactic radiosurgery (SRS), and furthermore, the introduction of intensity modulated radiation therapy (IMRT). Authors in this paper prospectively review the followings: the advancement of radiation oncology in Korea, the recent status of four-dimensional radiation therapy, IMRT, the concept of the treatment with biological conformity, the trend of combined chemoradiotherapy, the importance of internet and radiation oncology information management system as influenced by the revolution of information technology, and finally the global trend of telemedicine in radiation oncology. Additionally, we suggest the methods to improve radiotherapy treatment, which include improvement of quality assurance (QA) measures by developing Koreanized QA protocol and system, regional study about clinical protocol development for phase three clinical trial, suggestion of unified treatment protocol and guideline by academic or research societies, domestic generation of treatment equipment's or system, establishment of nationwide data base of radiation-oncology-related information, and finally patterns-of-care study about major cancers.

Key Words : Radiotherapy in Korea, Radiation oncology in new Millennium, New radiotherapy technique