付表 1．通常分割照射における正常組織の耐容線量

（小児については「小児–総論（☞ 352 ページ）」を参照のこと）

注意：(1) 本表で示される耐容線量はあくまでも臨床経験（2 Gy 前後の 1 回線量を用いクラークソン等の線量計算）を元にした参考値に過ぎず，合併症が起こらないことを保証する線量ではない。現在，原著報告時と異なり，線量計算方法，不均質補正の実施，1 回線量の増量，non-coplanar 照射さらに強度変調放射線治療等の実用化にみられるように大きな変化が起きているので新技術を応用するに当たっては十分この点に注意するべきである。

		TD5/5（5 年間で 5% に副作用を生ずる線量）			TD50/5（5 年間で 50% に副作用を生ずる線量）			判定基準
	体　積	1/3	2/3	3/3	1/3	2/3	3/3	
骨	大腿骨頭	—		52 Gy	—		65 Gy	壊　死
	顎関節	65 Gy	60 Gy		77 Gy	72 Gy		著明な開口障害
	肋　骨	50 Gy	—		65 Gy	—		病的骨折
皮　膚		$10\ cm^2$ / —	$30\ cm^2$	$100\ cm^2$ / 50 Gy	$10\ cm^2$ / —	$30\ cm^2$	$100\ cm^2$ / 65 Gy	毛細血管拡張
		70 Gy	60 Gy	55 Gy	—		70 Gy	壊死，潰瘍
脳・神経	脳	60 Gy	50 Gy	45 Gy	75 Gy	65 Gy	60 Gy	壊死，梗塞
	脳　幹	60 Gy	53 Gy	50 Gy	—		65Gy	壊死，梗塞
	視神経	50 Gy　体積効果なし			—		65Gy	失　明
	視交差	50 Gy　体積効果なし			65 Gy　体積効果なし			失　明
	脊　髄	5 cm / 50 Gy	10 cm	20 cm / 47 Gy	5 cm / 70 Gy	10 cm	20 cm / —	脊髄炎，壊死
	馬尾神経	60 Gy　体積効果なし			75 Gy　体積効果なし			臨床的に明らかな神経損傷
	腕神経叢	62 Gy	61 Gy	60 Gy	77 Gy	76 Gy	75 Gy	臨床的に明らかな神経損傷
	水晶体	10 Gy　体積効果なし			—		18 Gy	手術を要する白内障
	網　膜	45 Gy　体積効果なし			—		65 Gy	失　明

(2) 化学放射線療法における耐容線量は本表の値よりさらに低下すると予想される。
(3) 正常組織に変化がみられた場合にはCTCAEに従って正確に重症度を評価する必要がある。CTCAEv3.0日本語訳JCOG/JSCO版：http://www.jcog.jp/
(4) 本表の利用により生じたいかなる損害についても「放射線治療計画ガイドライン」作成ワーキンググループはその責を負わない。

(付表1 つづき)

		TD5/5 (5年間で5%に副作用を生ずる線量)			TD50/5 (5年間で50%に副作用を生ずる線量)			判定基準
	体 積	1/3	2/3	3/3	1/3	2/3	3/3	
頭頸部	中耳・外耳	30 Gy		30 Gy*	40 Gy		40 Gy*	急性漿液性耳炎
		55 Gy		55 Gy*	65 Gy		65 Gy*	慢性漿液性耳炎
	耳下腺	—	32 Gy*		—	46 Gy*		口内乾燥症 (TD100/5は50 Gy)
	喉 頭	79 Gy*	70 Gy*		90 Gy*	80 Gy*		軟骨壊死
		—	45 Gy	45 Gy*	—		80 Gy*	喉頭浮腫
胸部	肺	45 Gy	30 Gy	17.5 Gy	65 Gy	40 Gy	24.5 Gy	肺 炎
	心 臓	60 Gy	45 Gy	40 Gy	70 Gy	55 Gy	50 Gy	心外膜炎
	食 道	60 Gy	58 Gy	55 Gy	72 Gy	70 Gy	68 Gy	臨床的狭窄，穿孔
腹部	胃	60 Gy	55 Gy	50 Gy	70 Gy	67 Gy	65 Gy	潰瘍，穿孔
	小 腸	50 Gy		40 Gy*	60 Gy		55 Gy	閉塞，穿孔，瘻孔
	大 腸	55 Gy		45 Gy	65 Gy		55 Gy	閉塞，穿孔，潰瘍，瘻孔
	直 腸	100 cm^3 では体積効果なし		60 Gy	100 cm^3 では体積効果なし		80 Gy	高度の直腸炎，壊死，瘻孔，狭窄
	肝 臓	50 Gy	35 Gy	30 Gy	55 Gy	45 Gy	40 Gy	肝不全
	腎 臓	50 Gy	30 Gy*	23 Gy	—	40 Gy*	28 Gy	臨床的腎炎
	膀 胱	—	80 Gy	65 Gy	—	85 Gy	80 Gy	症候性の膀胱萎縮・体積減少

*50%以下の体積では明らかな変化は認めない

出典：Emami B, Lyman J, Brown A, et al. Tolerance of normal tissue to therapeutic irradiation. Int J Radiat Oncol Biol Phys 21：109–122, 1991.

付表 2. QUANTEC による正常組織の耐容線量

QUANTEC Summary : Approximate Dose/Volume/Outcome Data for Several Organs Following Conventional Fractionation (Unless Otherwise Noted)*

注意：(1) 本表は QUANTEC（The Quantitative Analysis of Normal Tissue Effects in the Clinic）により報告された論文（出典参照）の表を転載したものであり，内容については日本放射線腫瘍学会ガイドライン委員会および「放射線治療計画ガイドライン」ワーキンググループが独自に作成したものではない。

(2) 本表は，「付表 1」以降に三次元治療計画に基づく DVH データと有害事象の関係に関

Organ	Volume segmented	Irradiation type (partial organ unless otherwise stated)†	Endpoint
Brain	Whole organ	3D-CRT	Symptomatic necrosis
	Whole organ	3D-CRT	Symptomatic necrosis
	Whole organ	3D-CRT	Symptomatic necrosis
	Whole organ	SRS（single fraction）	Symptomatic necrosis
Brain stem	Whole organ	Whole organ	Permanent cranial neuropathy or necrosis
	Whole organ	3D-CRT	Permanent cranial neuropathy or necrosis
	Whole organ	3D-CRT	Permanent cranial neuropathy or necrosis
	Whole organ	SRS（single fraction）	Permanent cranial neuropathy or necrosis
Optic nerve/chiasm	Whole organ	3D-CRT	Optic neuropathy
	Whole organ	3D-CRT	Optic neuropathy
	Whole organ	3D-CRT	Optic neuropathy
	Whole organ	SRS（single fraction）	Optic neuropathy
Spinal cord	Partial organ	3D-CRT	Myelopathy
	Partial organ	3D-CRT	Myelopathy
	Partial organ	3D-CRT	Myelopathy
	Partial organ	SRS（single fraction）	Myelopathy
	Partial organ	SRS（hypofraction）	Myelopathy
Cochlea	Whole organ	3D-CRT	Sensory neural hearing loss
	Whole organ	SRS（single fraction）	Sensory neural hearing loss
Parotid	Bilateral whole parotid glands	3D-CRT	Long term parotid salivary function reduced to＜25% of pre-RT level
	Unilateral whole parotid gland	3D-CRT	Long term parotid salivary function reduced to＜25% of pre-RT level
	Bilateral whole parotid glands	3D-CRT	Long term parotid salivary function reduced to＜25% of pre-RT level

するデータをまとめた報告がQUANTECとして論文化されたため，本ガイドラインの参考資料として掲載をした。

(3) 本表の使用ならびに臨床適応については，出典の論文に書かれている注意事項を留意し，その限界についても十分に理解して参考にすることが望ましい。

(4) 本表の利用により生じたいかなる損害についても「放射線治療計画ガイドライン」作成ワーキンググループはその責を負わない。

★：出典論文の引用文献番号をそのまま記載しているため，論文の引用文献を参照のこと。

Dose (Gy), or dose/volume parameters†	Rate (%)	Notes on dose/volume parameters
Dmax＜60 Dmax＝72 Dmax＝90	＜3 5 10	Data at 72 and 90 Gy, extrapolated from BED models
V12＜5-10 cc	＜20	Rapid rise when V12 ＞ 5-10 cc
Dmax＜54 D1-10 cc‖ ≦59	＜5 ＜5	
Dmax＜64	＜5	Point dose≪1 cc
Dmax＜12.5	＜5	For patients with acoustic tumors
Dmax＜55 Dmax 55-60 Dmax ＞60	＜3 3-7 ＞7-20	Given the small size, 3D CRT is often whole organ‡‡
Dmax＜12	＜10	
Dmax＝50 Dmax＝60 Dmax＝69	0.2 6 50	Including full cord cross-section
Dmax＝13 Dmax＝20	1 1	Partial cord cross-section irradiated 3 fractions, partial cord cross-section irradiated
Mean dose≦45	＜30	Mean dose to cochlear, hearing at 4 kHz
Prescription dose≦14	＜25	Serviceable hearing
Mean dose＜25	＜20	For combined parotid glands¶
Mean dose＜20	＜20	For single parotid gland. At least one parotid gland spared to＜20 Gy¶
Mean dose＜39	＜50	For combined parotid glands (per Fig. 3 in paper★)¶

（付表２ つづき）

Organ	Volume segmented	Irradiation type (partial organ unless otherwise stated)†	Endpoint
Pharynx	Pharyngeal constrictors	Whole organ	Symptomatic dysphagia and aspiration
Larynx	Whole organ	3D-CRT	Vocal dysfunction
	Whole organ	3D-CRT	Aspiration
	Whole organ Whole organ	3D-CRT 3D-CRT	Edema Edema
Lung	Whole organ	3D-CRT	Symptomatic pneumonitis
	Whole organ Whole organ Whole organ Whole organ Whole organ	3D-CRT 3D-CRT 3D-CRT 3D-CRT 3D-CRT	Symptomatic pneumonitis Symptomatic pneumonitis Symptomatic pneumonitis Symptomatic pneumonitis Symptomatic pneumonitis
Esophagus	Whole organ	3D-CRT	Grade ≧3 acute esophagitis
	Whole organ Whole organ Whole organ	3D-CRT 3D-CRT 3D-CRT	Grade ≧2 acute esophagitis Grade ≧2 acute esophagitis Grade ≧2 acute esophagitis
Heart	Pericardium Pericardium	3D-CRT 3D-CRT	Pericarditis Pericarditis
	Whole organ	3D-CRT	Long-term cardiac mortality
Liver	Whole liver−GTV Whole liver−GTV	3D-CRT or Whole organ 3D-CRT	Classic RILD†† Classic RILD
	Whole liver−GTV Whole liver−GTV	3D-CRT or Whole organ 3D-CRT	Classic RILD Classic RILD
	Whole liver−GTV Whole liver−GTV	SBRT（hypofraction） SBRT（hypofraction）	Classic RILD Classic RILD
	＞700 cc of normal liver	SBRT（hypofraction）	Classic RILD
Kidney	Bilateral whole kidney‡ Bilateral whole kidney‡	Bilateral whole organ or 3D-CRT Bilateral whole organ	Clinically relevant renal dysfunction Clinically relevant renal dysfunction
	Bilateral whole kidney‡	3D-CRT	Clinically relevant renal dysfuntction
Stomach	Whole organ	Whole organ	Ulceration

Dose (Gy), or dose/volume parameters†	Rate (%)	Notes on dose/volume parameters
Mean dose＜50	＜20	Based on Section B4 in paper★
Dmax＜66	＜20	With chemotherapy, based on single study (see Section A4.2 in paper★)
Mean dose＜50	＜30	With chemotherapy, based on single study (see Fig. 1 in paper★)
Mean dose＜44 V50＜27%	＜20 ＜20	Without chemotherapy, based on single study in patients without larynx cancer**
V20≦ 30%	＜20	For combined lung. Gradual dose response
Mean dose＝7 Mean dose＝13 Mean dose＝20 Mean dose＝24 Mean dose＝27	5 10 20 30 40	Excludes purposeful whole lung irradiation
Mean dose＜34	5–20	Based on RTOG and several studies
V35＜50% V50＜40% V70＜20%	＜30 ＜30 ＜30	A variety of alternate threshold doses have been implicated. Appears to be a dose/volume response
Mean dose＜26 V30＜46%	＜15 ＜15	Based on single study
V25＜10%	＜1	Overly safe risk estimate based on model predictions
Mean dose＜30–32 Mean dose＜42	＜5 ＜50	Excluding patients with pre-existing liver disease or hepatocellular carcinoma, as tolerance doses are lower in these patients
Mean dose＜28 Mean dose＜36	＜5 ＜50	In patients with Child-Pugh A preexisting liver disease or hepatocellular carcinoma, excluding hepatitis B reactivation as an endpoint
Mean dose＜13 ＜18 Mean dose＜15 ＜20	＜5 ＜5 ＜5 ＜5	3 fractions, for primary liver cancer 6 fractions, for primary liver cancer 3 fractions, for liver metastases 6 fractions, for liver metastases
Dmax＜15	＜5	Critical volume based, in 3–5 fractions
Mean dose＜15–18 Mean dose＜28	＜5 ＜50	
V12＜55% V20＜32% V23＜30% V28＜20%	＜5	For combined kidney
D100‖＜45	＜7	

（付表２　つづき）

Organ	Volume segmented	Irradiation type (partial organ unless otherwise stated) †	Endpoint
Small bowel	Individual small bowel loops	3D-CRT	Grade ≧ 3 acute toxicity §
	Entire potential space within peritoneal cavity	3D-CRT	Grade ≧ 3 acute toxicityx §
Rectum	Whole organ	3D-CRT	Grade ≧ 2 late rectal toxicity, Grade ≧ 3 late rectal toxicity
	Whole organ	3D-CRT	Grade ≧ 2 late rectal toxicity, Grade ≧ 3 late rectal toxicity
	Whole organ	3D-CRT	Grade ≧ 2 late rectal toxicity, Grade ≧ 3 late rectal toxicity
	Whole organ	3D-CRT	Grade ≧ 2 late rectal toxicity, Grade ≧ 3 late rectal toxicity
	Whole organ	3D-CRT	Grade ≧ 2 late rectal toxicity, Grade ≧ 3 late rectal toxicity
Bladder	Whole organ	3D-CRT	Grade ≧ 3 late RTOG
	Whole organ	3D-CRT	Grade ≧ 3 late RTOG
Penile bulb	Whole organ	3D-CRT	Severe erectile dysfunction
	Whole organ	3D-CRT	Severe erectile dysfunction
	Whole organ	3D-CRT	Severe erectile dysfunction

Abbreviations：3D-CRT = 3-dimensional conformal radiotherapy
SRS = stereotactic radiosurgery
BED = Biologically effective dose
SBRT = stereotactic body radiotherapy
RILD = radiation-induced liver disease
RTOG = Radiation Therapy Oncology Group.

* All data are estimated from the literature summarized in the QUANTEC reviews unless otherwise noted. Clinically, these data should be applied with caution. Clinicians are strongly advised to use the individual QUANTEC articles to check the applicability of these limits to the clinical situation at hand. They largely do not reflect modern IMRT.

† All at standard fractionation (*i.e.*, 1.8–2.0 Gy per daily fraction) unless otherwise noted. Vx is the volume of the organ receiving ≧ x Gy. Dmax = Maximum radiation dose.

‡ Non-TBI.

Dose (Gy), or dose/volume parameters†	Rate (%)	Notes on dose/volume parameters
V15＜120 cc	＜10	Volume based on segmentation of the individual loops of bowel, not the entire potential peritoneal space
V45＜195 cc	＜10	Volume based on the entire potential space within the peritoneal cavity
V50＜50% V60＜35% V65＜25% V70＜20% V75＜15%	＜15 ＜10 ＜15 ＜10 ＜15 ＜10 ＜15 ＜10 ＜15 ＜10	Prostate cancer treatment
Dmax＜65	＜6	Bladder cancer treatment. Variations in bladder size/shape/ location during RT hamper ability to generate accurate data
V65≦50% V70≦35% V75≦25% V80≦15%		Prostate cancer treatment Based on current RTOG 0415 recommendation
Mean dose to 95% of gland＜50 D90‖＜50 D60-70＜70	＜35 ＜35 ＜55	

§ With combined chemotherapy.

‖ Dx＝minimum dose received by the "hottest" x% (or x cc's) of the organ.

¶ Severe xerostomia is related to additional factors including the doses to the submandibular glands.

** Estimated by Dr. Eisbruch.

†† Classic Radiation induced liver disease (RILD) involves anicteric hepatomegaly and ascites, typically occurring between 2 weeks and 3 months after therapy. Classic RILD also involves elevated alkaline phosphatase (more than twice the upper limit of normal or baseline value).

‡‡ For optic nerve, the cases of neuropathy in the 55 to 60 Gy range received ≈ 59 Gy (see optic nerve paper for details★). Excludes patients with pituitary tumors where the tolerance may be reduced.

出典：Marks LB, Yorke ED, Jackson A, et al. Use of normal tissue complication probability models in the clinic. Int J Radiat Oncol Biol Phys 76 (3 Suppl)：S10-19, 2010.