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CANCER OF THE HEAD AND NECK IN ATOMIC BOMB SURVIVORS, HIROSHIMA AND NAGASAKI, 1957-76

原爆被爆者における頭・頸部の癌，広島及び長崎，1957－76年

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SUMMARY

A search for all possible cases of head and neck cancer (lip, nose and nasal cavity, accessory sinuses, larynx, and the oral cavity and pharynx with their subdivisions) occurring during the period 1957-76 among a fixed cohort of A-bomb survivors (Life Span Study extended sample) was conducted utilizing multiple sources in both Hiroshima and Nagasaki; 232 possible cases were identified (total cases), of which 154 (66.4%) were histologically confirmed (definite cases). Among definite cases, cancer of the epiglottis and larynx predominated (31.2%), followed by accessory sinus (24.7%), and tongue (18.8%). Of the 154 definite cases 141 (91.6%) were squamous cell carcinomas. Only two sarcomas were identified, neither of which were attributed to radiation exposure. Analysis of both total and definite cases, by both total group and major anatomic site, failed to reveal definite evidence of a relationship to radiation exposure. Although among definite cases a suggestive relationship to radiation dose was found for accessory sinus cancers (P=.06), inconsistencies in the data do not permit the conclusion that the incidence of tumors in this group is increased as a result of A-bomb radiation exposure. Prior reports on the possible relationship of radiation exposure to the later development of malignant head and neck tumors are briefly reviewed.

要　約

広島・長崎両市の各種の資料源を利用して，原爆被爆者の固定集団（寿命調査拡大対象群）における1957－76年の頭・頸部癌（唇，鼻及び鼻腔，副鼻腔，喉頭，口腔及び咽頭とその細目）とみなされる全症例について調査を行った．癌とみなし得る症例が232例探知され（全症例），そのうち154例（66.4%）が組織学的に確認された（診断確実例）．診断確実例中最も多かったのは喉頭蓋及び喉頭の癌（31.2%）で，次いで副鼻腔（24.7%），舌（18.8%）の癌が多かった．154例の診断確実例中141例（91.6%）が扁平上皮癌であった．肉腫はわずか2例しか確認されず，2例とも放射線被曝によるものとは考えられなかった．全症例及び診断確実例の双方について，総括的にも主要部位別にも解析したが，放射線被曝との明らかな関係は認められなかった．診断確実例中では副鼻腔癌と放射線量との間に有意な関係が示唆されたが（P＝.06），資料に見られた一貫性の欠除は，この群の腫瘍発生率が原爆放射線被曝の結果高くなっていると結論を出すことはできない．放射線被曝と頭・頸部悪性腫瘍の発現との関係に関するこれまでの報告論文を簡単に考察した．

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INTRODUCTION

Long-term follow-up of the exposed survivors of the A-bombs of Hiroshima and Nagasaki has provided a major share of the knowledge concerning the radiation induction of cancer in man. Radiation relationships have been investigated for several types of neoplasms, and strong statistical correlations with dose for leukemia,[1-8] lymphoma,[9,10] thyroid cancer,[11,12] lung cancer,[13-15] and female breast cancer[16-18] are established. There is suggestive evidence of a radiation relationship for salivary gland tumors.[19,20] In heavily exposed children under 10 years of age at the time of the A-bombs (ATB), an increased risk of cancer at various sites also has been reported.[21]

The present study investigated the possibility of a radiation relationship for head and neck cancer among A-bomb survivors. Sites surveyed were the lip, nose and nasal cavity, accessory sinuses, larynx, and the oral cavity and pharynx with their subdivisions. Tumors of the thyroid and salivary glands have been studied separately,[11,12,19,20] and were not included in the present analysis.

MATERIALS AND METHODS

Population

The RERF Life Span Study (LSS) extended sample[22] is the population under long-term surveillance for delayed effects of the A-bombs. The original sample numbered approximately 109,000 persons from both Hiroshima and Nagasaki, and is composed of individuals who received various radiation doses as well as their age and sex matched controls.

Source of Tumor Information

Tumor information was obtained from several sources, which are listed in Table 1. By special arrangement with the Ministry of Health and Welfare of Japan, RERF receives death certificates for all deaths in the LSS extended sample. In both Hiroshima and Nagasaki a broad search was conducted for all possible cases of head and neck tumors. The records of the University Hospital, Hiroshima University School of Medicine, as well as the Kinen, Citizen's, and Toyo Kogyo Hospital of Hiroshima, were reviewed. The Tumor and Tissue Registries of both cities were also searched, as well as the RERF surgical pathology and autopsy files for the periods indicated.

緒　言

広島・長崎の原爆被爆者に関する長期追跡調査は，ヒトの癌の放射線誘発に関する知見について大きな貢献をしている．幾つかの種類の新生物について放射線との関係が研究され，白血病，[1-8] リンパ腫，[9,10] 甲状腺癌，[11,12] 肺癌，[13-15] 及び女性乳癌[16-18] と線量との強い統計学的相関が確認されている．また，唾液腺腫瘍と放射線との関連を示唆する所見もある．[19,20] 原爆時10歳未満で高線量に被曝した者には，癌の危険率が多くの部位で増加していることも報告されている．[21]

本研究では原爆被爆者における頭・頸部癌と放射線との関係を調査した．調査対象部位は，唇，鼻及び鼻腔，副鼻腔，喉頭，口腔及び咽頭とその細目であった．甲状腺癌及び唾液腺癌は別途に調査してあるので，[11,12,19,20] 今回の解析には含めなかった．

調査対象及び方法

対象集団

放影研の寿命調査（LSS）拡大対象群[22] が，原爆の遅発性影響に関する長期調査の対象集団である．当初の対象者は広島・長崎両市の約109,000人から成り，種々の放射線量の被爆者と年齢と性を一致させた対照者から構成されている．

腫瘍資料源

腫瘍資料は表1に掲げた幾つかの資料源から入手した．放影研は厚生省の特別な取り計らいにより，寿命調査拡大集団中の死亡例について死亡診断書をすべて入手している．広島・長崎両市の頭・頸部癌とみなされる全症例について広範な調査を行った．すなわち広島の記念病院，市民病院，東洋工業病院並びに広島大学医学部付属病院の資料を検討した．更に広島・長崎両市の腫瘍登録及び組織登録を調査し，当該期間の放影研外科病理標本及び剖検標本の記録も調査した．

TABLE 1 SOURCE OF TUMOR INFORMATION
表1　腫瘍の資料源

Source	Number of Cases	
	Hiroshima	Nagasaki
Tumor Registry (1957-76)*	156	54
Department of Otorhinolaryngology, University Hospital (1957-76)	54	–
Tissue Registry (1973-76)	40	–
Death Certificate (1957-76)	127	40
Citizen's, Kinen, and Toyo Kogyo Hospitals	25	–
Total**	178	54
Cities combined	232	

Includes all material from RERF surgical pathology and autopsy files. In Nagasaki, the Tumor Registry includes material from the Tissue Registry (1974-75), and cases from the records of the University Hospital, Nagasaki University School of Medicine.
放影研の外科病理標本及び剖検標本の全資料を含む．長崎の場合，腫瘍登録は組織登録(1974－75)の資料及び長崎大学医学部付属病院の記録も含む．

***Most cases were listed in more than one source.*
ほとんどの症例は二つ以上の資料源に記載されている．

Certainty of Diagnosis

Case material was assigned to one of three diagnostic certainty categories based on histological verification as follows:

1. Possible – death certificate information or other nonhistologically confirmed report of head and neck tumor.

2. Probable – histological confirmation of tumor outside of RERF, but not by either Tissue Registry, or university hospital pathologist.

3. Definite – histological confirmation at RERF, by a university pathologist, or either Tissue Registry.

Dosimetry

The RERF dosimetry system rests on work performed at both the Oak Ridge National Laboratory[23] and the National Institute of Radiological Sciences of Japan.[24] Exposed persons in the LSS extended sample have been assigned an air dose estimate in rad, designated T65D. Separate gamma and neutron doses have been calculated, but the total dose, as used in this report, is the simple sum of the two. Four dose categories have been used to facilitate analysis of radiation effect: those not in city (NIC) ATB, 0 rad, 1-99 rad, and 100+ rad.

診断の確実度

各症例を，組織学的確認の度合いに基づいて下記のように3種の診断確実度に分類した．

1．不確実：頭・頸部の腫瘍に関する診断で，死亡診断書又は病理組織学的ではないその他の方法によって確認された例．

2．ほぼ確実：放影研以外で(ただし，組織登録又は大学病院の病理医によるものでもなくて)組織学的に確認された腫瘍．

3．確実：放影研，大学の病理学者，組織登録により組織学的に確認されたもの．

線量測定

放影研の線量測定方式は，米国のOak Ridge研究所[23]及び日本の放射線医学総合研究所[24]の両者が行った作業に依存している．寿命調査拡大集団中の被爆者は，T65Dと称するrad単位の空気線量推定値が決められている．ガンマ線量及び中性子線量は別々に算出したが，本報告で使用している総線量はガンマ線量及び中性子線量の単純合計である．放射線後影響の解析を容易にするために四つの線量区分(原爆時市内不在者群，0 rad群，1－99rad群及び100 rad以上群)を使用した．

Statistical Analysis

Significance testing was performed using the chi-square statistic, calculated as follows:

$$\chi^2 = \sum^{r} \sum^{c} (N_{ij} - E_{ij})^2 / E_{ij}$$

$$\text{where } E_{ij} = \frac{N_{i\cdot} \, N_{\cdot j}}{N_{\cdot\cdot}} \qquad df = (r-1)(c-1)$$

RESULTS

The number of cases accrued by source is shown in Table 1. A total of 232 cases were found, 178 from Hiroshima and 54 from Nagasaki. Since some cases were listed in more than one source, the total number of cases accrued was less than the sum of the cases from each source.

The distribution of cases by sex, city, and diagnostic certainty category is shown in Table 2. Definite cases numbered 154 (66.4%), with 109 from Hiroshima and 45 from Nagasaki (Appendix 1). Probable cases numbered 22 and accounted for only 9.5%, with 21 from Hiroshima and 1 from Nagasaki. Possible cases numbered 56 (24.1%), with 48 from Hiroshima and 8 from Nagasaki.

Total cases by site, sex, and city are presented in Table 3. Classification by site was based on the Systematized Nomenclature of Pathology (SNOP), College of American Pathologists, 1965. Epiglottis and larynx was the most frequent site (74 cases, 31.9%), followed by accessory sinus (59 cases, 25.4%), and tongue (44 cases, 19.0%). Although the LSS extended sample contains a greater number of females (63,263) than males (45,497), a female:male ratio of 1.0:0.7, males accounted for 135 and females 97 of the total 232 cases, (F:M=1.0:1.4). These trends reflect the greater incidence of cancer of these sites, considered as a group, in males than females.[25] Cancer of the nasopharynx was relatively infrequent, accounting for only 6 (2.6%) of the total 232 cases. This is consistent with the fact that the incidence of nasopharynx cancer in Japanese is essentially the same as in the U.S. Caucasian population and does not occur with the high frequency seen in other Orientals, notably ethnic Chinese.[26]

The frequency of major sites by sex and city for definite cases is shown in Table 4. Essentially

統計学的解析

下記のように χ^2 統計を用いて有意性検定を行った．

結　果

資料源別に得られた症例数を表1に示した．合計232例を確認し，そのうち広島は178例，長崎は54例であった．幾つかの症例は2か所以上の情報源から入手しているので，得られた全症例数は各情報源からの症例の合計より少ない．

性別，都市別及び診断確実度の分類別の症例分布を表2に示した．診断確実例は154（66.4%）であり，広島は109例，長崎は45例であった（付録1）．診断ほぼ確実例は22で，9.5%を占めるにすぎない．広島は21例，長崎は1例であった．診断不確実例は56（24.1%）で，広島は48例，長崎は8例であった．

部位別，性別，都市別の全症例を表3に示した．部位別分類は，College of American Pathologists 編集の Systematized Nomenclature of Pathology（SNOP）（1965年）に基づいて行った．喉頭蓋及び喉頭が癌発生頻度の最も高い部位であり（74例，31.9%），次いで副鼻腔（59例，25.4%），舌（44例，19.0%）であった．寿命調査拡大集団は女性（63,263人）の方が男性（45,497人）より多く，女性対男性比は1.0：0.7であるのに，全症例232例のうち男性は135例，女性は97例であった（女性対男性＝1.0：1.4）．このような傾向は，これらの部位を一つにまとめてみると，その癌発生率は女性より男性の方が高いということを示している．[25] 鼻咽頭癌は比較的頻度が低く，全232例中6例（2.6%）にしかすぎない．このことは，日本人における鼻咽頭癌の発生率は，本来米国の白人と同じであり，その他の東洋人，特に民族学的な意味での中国人に見られるような高い頻度を日本人は示さないという事実と一致する．[26]

診断確実例について主要部位別の発癌頻度を性別，都市別に表4に示した．本質的には，全症例について

TABLE 2 CERTAINTY OF DIAGNOSIS BY CITY AND SEX
表2　都市別，性別の診断確実度

Diagnostic Certainty Category		Hiroshima			Nagasaki			Cities Combined		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
Definite	No.	109	67	42	45	25	20	154	92	62
	%	61.2			83.3			66.4	68.2	63.9
Probable	No.	21	12	9	1	1	–	22	13	9
	%	11.8			1.9			9.5	9.6	9.3
Possible	No.	48	25	23	8	5	3	56	30	26
	%	27.0			14.8			24.1	22.2	26.8
Total	No.	178	104	74	54	31	23	232	135	97
	%	100.0			100.0			100.0	100.0	100.0

Definite: *Histologically confirmed at RERF, by a university pathologist, or either Tissue Registry.*

確実：放影研，大学の病理学者，もしくは組織登録により組織学的に確認されたもの．

Probable: *Histological confirmation of tumor outside of RERF, but not by either Tissue Registry, or university hospital pathologist.*

ほぼ確実：放影研以外（ただし，組織登録又は大学病院の病理医によるものではない）で組織学的に確認された腫瘍．

Possible: *Death certificate information or other nonhistologically confirmed report of head and neck neoplasm.*

不確実：頭・頚部の腫瘍に関する診断で，死亡診断書または病理組織学的ではないその他の方法によって確認された例．

the same order of frequency of occurrence by site was found as for total cases (Table 3), with the most frequent site being epiglottis and larynx (48 cases, 31.2%), followed by accessory sinus (38 cases, 24.7%), and tongue (29 cases, 18.8%). Among females, the most frequently occurring site was accessory sinus (37.1%) whereas among males, cancer of the epiglottis and larynx predominated (43.5%). In Hiroshima, tongue cancer comprised 22.9% of the total, whereas the figure in Nagasaki was 8.9%. This difference, however, was not statistically significant ($P > .30$). The female:male ratio among definite cases was 1.0:1.5.

Histology according to site of origin for all definite cases is shown in Table 5. Histological classification was made according to SNOP. Of the total 154 cases 141 (91.6%) were squamous carcinomas. Only two sarcomas were identified, both occurring in an accessory sinus. One, a fibrosarcoma, occurred in a Hiroshima female who was not in the city ATB. The other, an unclassified sarcoma, occurred in a Nagasaki female whose T65 dose was 5 rad. Histology according to city, sex, and dose for definite cases is shown in Table 6. No significant effect on the distribution of histological types was found for any of these parameters.

の部位別発生頻度順序と同じ順序が認められた（表３）．すなわち，発生頻度の最も高い部位は喉頭蓋及び喉頭であり（48例，31.2%），次いで副鼻腔（38例，24.7%），舌（29例，18.8%）であった．女性において最も発生頻度の高い部位は副鼻腔（37.1%）であり，男性では喉頭蓋癌及び喉頭癌の発生率が最も高かった（43.5%）．広島では舌癌は全体の22.9%を占め，長崎では8.9%を占めた．しかしこの差は統計的に有意ではなかった（$P > .30$）．診断確実例の女性対男性の比は1.0：1.5であった．

診断確実の全例について発生部位別にみた組織型を表５に示した．組織分類は SNOP に従って行った．全154例中141例（91.6%）が扁平上皮癌であった．肉腫はわずか２例しか確認されず，２例とも副鼻腔に発生したものであった．そのうち１例は線維肉腫で．原爆投下時市内にいなかった広島の女性に発生したものである．もう１例は分類されていない肉腫で，T65推定線量が５rad である長崎の女性に発生したものである．診断確実例の都市，性，線量別に見た組織型を表６に示した．組織型の分布に対するこれらのパラメーターの有意な影響は見られなかった．

TABLE 3 FREQUENCY OF MAJOR SITES BY CITY AND SEX, TOTAL CASES

表3　都市別，性別の主要部位の頻度（全症例）

SNOP CODE	Site	Hiroshima		Nagasaki		Cities Combined				Sexes Combined				Total	
						Male		Female		Hiroshima		Nagasaki			
		Male	Female	Male	Female	No.	%	No.	%	No.	%	No.	%	No.	%
21	Nose	5	2	–	2	5	3.7	4	4.1	7	4.0	2	3.7	9	3.9
22	Accessory sinus	18	23	7	11	25	18.5	34	35.0	41	23.0	18	33.3	59	25.4
23	Nasopharynx	3	1	1	1	4	3.0	2	2.1	4	2.2	2	3.7	6	2.6
24	Epiglottis & Larynx	44	13	15	2	59	43.7	15	15.5	57	32.1	17	31.5	74	31.9
51	Mouth	6	5	–	2	6	4.4	7	7.2	11	6.2	2	3.7	13	5.6
52	Lip	1	1	1	1	2	1.5	2	2.1	2	1.1	2	3.7	4	1.7
53	Tongue	16	23	3	2	19	14.1	25	25.8	39	21.9	5	9.3	44	19.0
54	Gum	5	5	2	2	7	5.2	7	7.2	10	5.6	4	7.4	14	6.0
60	Pharynx	1	1	2	–	3	2.2	1	1.0	2	1.1	2	3.7	4	1.7
61	Tonsil	5	–	–	–	5	3.7	–	–	5	2.8	–	–	5	2.2
	Total	104	74	31	23	135	100.0	97	100.0	178	100.0	54	100.0	232	100.0

TABLE 4 FREQUENCY OF MAJOR SITES BY CITY AND SEX, DEFINITE CASES

表 4　都市別，性別の主要部位の頻度（診断確実例）

SNOP CODE	Site	Hiroshima		Nagasaki		Cities Combined				Sexes Combined				Total	
		Male	Female	Male	Female	Male		Female		Hiroshima		Nagasaki			
						No.	%	No.	%	No.	%	No.	%	No.	%
21	Nose	3	1	–	1	3	3.3	2	3.2	4	3.7	1	2.2	5	3.2
22	Accessory sinus	10	13	5	10	15	16.3	23	37.1	23	21.1	15	33.3	38	24.7
23	Nasopharynx	3	–	1	1	4	4.3	1	1.6	3	2.8	2	4.5	5	3.2
24	Epiglottis & Larynx	27	6	13	2	40	43.5	8	12.9	33	30.3	15	33.3	48	31.2
51	Mouth	5	4	–	2	5	5.4	6	9.7	9	8.2	2	4.5	11	7.1
52	Lip	–	–	–	1	–	–	1	1.6	–	–	1	2.2	1	0.7
53	Tongue	11	14	3	1	14	15.2	15	24.2	25	22.9	4	8.9	29	18.8
54	Gum	4	4	1	2	5	5.4	6	9.7	8	7.3	3	6.6	11	7.1
60	Pharynx	1	–	2	–	3	3.3	–	–	1	0.9	2	4.5	3	2.0
61	Tonsil	3	–	–	–	3	3.3	–	–	3	2.8	–	–	3	2.0
	Total	67	42	25	20	92	100.0	62	100.0	109	100.0	45	100.0	154	100.0

TABLE 5 DEFINITE CASES BY HISTOLOGICAL TYPE AND SITE

表 5　組織型及び部位別の診断確実例

SNOP CODE	Histological Type	Total	SNOP CODE									
			21 Nose	22 Accessory Sinus	23 Nasopharynx	24 Epiglottis Larynx	51 Mouth	52 Lip	53 Tongue	54 Gum	60 Pharynx	61 Tonsil
8023	Undifferentiated carcinoma	1	–	–	1	–	–	–	–	–	–	–
8073	Squamous cell carcinoma	141	4	34	3	48	9	1	26	10	3	3
8143	Adenocarcinoma	1	–	–	–	–	1	–	–	–	–	–
8203	Adenoid cystic carcinoma	6	1	2	–	–	–	–	2	1	–	–
8433	Mucoepidermoid carcinoma	1	–	–	–	–	1	–	–	–	–	–
8723	Malignant melanoma	1	–	–	1	–	–	–	–	–	–	–
8803	Sarcoma	1	–	1	–	–	–	–	–	–	–	–
8823	Fibrosarcoma	1	–	1	–	–	–	–	–	–	–	–
9373	Granular cell myoblastoma, malignant	1	–	–	–	–	–	–	1	–	–	–
	Total	154	5	38	5	48	11	1	29	11	3	3

TABLE 6 DEFINITE CASES BY HISTOLOGICAL TYPE, CITY, SEX, AND EXPOSURE GROUP

表 6　組織型，都市，性及び被曝群別診断確実例

SNOP CODE	Histological Type	Hiroshima		Nagasaki		Exposure Group, Cities Combined T65 Dose in rad					
		Male	Female	Male	Female	NIC	0	1-99	100+	Unk	Total
8023	Undifferentiated carcinoma	–	–	1	–	–	–	1	–	–	1
8073	Squamous cell carcinoma	64	38	23	16	33	40	60	5	3	141
8143	Adenocarcinoma	–	1	–	–	–	1	–	–	–	1
8203	Adenoid cystic carcinoma	1	2	1	2	–	1	3	1	1	6
8433	Mucoepidermoid carcinoma	–	–	–	1	–	1	–	–	–	1
8723	Malignant melanoma	1	–	–	–	1	–	–	–	–	1
8803	Sarcoma	–	–	–	1	–	–	1	–	–	1
8823	Fibrosarcoma	–	1	–	–	1	–	–	–	–	1
9373	Granular cell myoblastoma, malignant	1	–	–	–	1	–	–	–		1
	Total	67	42	25	20	36	43	65	6	4	154

A comparison of clinical and histological diagnoses for definite cases is shown in Table 7. "Clinical" diagnoses included all diagnoses not made histologically, such as those recorded on death certificates and some Tumor Registry diagnoses. In general there was a good correlation, although in eight cases (5.2%), histological examination resulted in a revision of the clinical diagnosis. Another eight cases (5.2%) were found only through histological examination.

診断確実例の臨床的診断と組織学的診断との比較を表7に示した．"臨床"診断には組織学的に行われなかったすべての診断，すなわち，死亡診断書に記載されたもの及び腫瘍登録の診断の幾らかのものなどを含めた．おおむねよい相関が見られたが，8例(5.2%)においては組織学的検査の結果臨床診断の訂正が行われることになった．更に8例(5.2%)が組織学的検査のみにより確認された．

Occurrence of cancer by site and radiation dose, cities and sexes combined, for total and definite cases is shown in Table 8. No definite radiation relationship was seen for any site in either the total or definite case group. The analysis of the distribution of observed to expected cases of cancer from the three most common sites (accessory sinus, epiglottis and larynx, and tongue) is shown in Table 9 for total cases, and Table 10 for definite cases. A relative risk of 1.0 was assigned to the group with a T65 dose of 0 rad. Although no definite evidence of a radiation relationship was observed, a suggestive relationship was found for accessory sinus cancer in the definite case group (χ^2=7.44, P=.06). Accessory sinus was the only site for which the relative risk in the 100+ rad group was above 1.0. The number of cases, however, is quite small; only two cases of accessory sinus cancer were observed in the 100+ rad group in the definite case category. In addition, in the 0 rad group only 5 cases were observed, while 10.0 or 11.5 were expected.

全症例及び診断確実例に対する都市及び男女合計の部位別，放射線量別の癌発生例を表8に示した．全症例群においても診断確実例群においても，放射線との明確な関係はどの部位にも認められなかった．癌発生の最も多い三つの部位(副鼻腔，喉頭蓋・喉頭，及び舌)の癌観察例数及び期待値の分布の解析を，全症例については表9に，診断確実例については表10に示した．T65推定線量0 rad 群を相対的危険度1.0とした．放射線との関係について明らかな所見は見られなかったが，診断確実例の群において副鼻腔癌と放射線との関係が示唆された(χ^2 =7.44, P =.06)．副鼻腔は，100rad 以上群の相対的危険度が1.0以上である唯一の部位であった．しかしながら症例数は極めて少なく，診断確実例の100rad 以上群で2例の副鼻腔癌が認められたにすぎない．その上，0 rad 群においては，期待値が10.0ないし11.5例であったにもかかわらず5例しか確認されなかった．

TABLE 7 COMPARISON BETWEEN CLINICAL DIAGNOSIS AND HISTOLOGICAL DIAGNOSIS, DEFINITE CASES

表 7　臨床診断と組織診断の比較（診断確実例）

SNOP CODE	Clinical Diagnosis	Total	SNOP Code & Histological Diagnosis									
			21 Nose	22 Accessory Sinus	23 Nasopharynx	24 Epiglottis Larynx	51 Mouth	52 Lip	53 Tongue	54 Gum	60 Pharynx	61 Tonsil
21	Nose	4	3	1	–	–	–	–	–	–	–	–
22	Accessory sinus	37	1	34	1	–	–	–	–	1	–	–
23	Nasopharynx	4	–	–	4	–	–	–	–	–	–	–
24	Epiglottis & Larynx	47	–	–	–	46	–	–	–	1	–	–
51	Mouth	12	1	–	–	–	10	–	–	–	1	–
52	Lip	1	–	–	–	–	–	1	–	–	–	–
53	Tongue	26	–	–	–	–	–	–	26	–	–	–
54	Gum	9	–	–	–	–	–	–	–	9	–	–
60	Pharynx	3	–	–	–	–	–	–	1	–	2	–
61	Tonsil	3	–	–	–	–	–	–	–	–	–	3
	No clinical diagnosis	8	–	3	–	2	1	–	2	–	–	–
	Total	154	5	38	5	48	11	1	29	11	3	3

TABLE 8 TOTAL AND DEFINITE CASES BY SITE AND RADIATION DOSE, SEXES AND CITIES COMBINED

表 8　部位別，放射線量別の全症例及び診断確実例（男女・両市合計）

SNOP CODE	Site	Total Cases						Definite Cases					
		Total	T65 Dose in rad					Total	T65 Dose in rad				
			NIC	0	1-99	100+	Unk.		NIC	0	1-99	100+	Unk.
21	Nose	9	–	3	5	–	1	5	–	2	3	–	–
22	Accessory sinus	59	12	12	29	3	3	38	8	5	20	2	3
23	Nasopharynx	6	2	2	2	–	–	5	2	1	2	–	–
24	Epiglottis & Larynx	74	15	25	29	4	1	48	9	16	20	2	1
51	Mouth	13	7	4	2	–	–	11	6	4	1	–	–
52	Lip	4	2	1	1	–	–	1	–	–	1	–	–
53	Tongue	44	12	13	18	1	–	29	10	8	10	1	–
54	Gum	14	1	5	8	–	–	11	–	5	6	–	–
60	Pharynx	4	1	2	–	1	–	3	1	1	–	1	–
61	Tonsil	5	1	2	2	–	–	3	–	1	2	–	–
	Total	232	53	69	96	9	5	154	36	43	65	6	4

TABLE 9 STATISTICAL ANALYSIS OF CANCER OF THE ACCESSORY SINUS, EPIGLOTTIS AND LARYNX, AND TONGUE, SEXES AND CITIES COMBINED, TOTAL CASES

表 9　全症例の副鼻腔癌，喉頭蓋及び喉頭癌，舌癌の統計的解析（男女・両市合計）

SNOP Code	Site	Total	T65 Dose in rad				
			NIC	0	1-99	100+	Unk.
	All sites combined	232	53	69	96	9	5
22	Accessory Sinus						
	Observed	59	12	12	29	3	3
	Expected (total)*	(56.0)	13.1	17.0	23.7	2.2	–
	Expected (LSS sample)**	(56.0)	13.7	18.3	20.8	3.2	–
	Rate/10^5 (LSS) person-years	2.4	2.0	1.5	3.2	2.2	5.6
	Relative risk	–	1.3	**1.0**	2.1	1.4	3.7
	Test to Total		$\chi^2 = 4.030$		P > .20	NS	
	Test to LSS		$\chi^2 = 5.634$		P > .10	NS	
24	Epiglottis & Larynx						
	Observed	74	15	25	29	4	1
	Expected (total)*	(73.0)	17.0	22.2	30.9	2.9	–
	Expected (LSS sample)**	(73.0)	17.8	23.9	27.1	4.2	–
	Rate/10^5 (LSS) person-years	3.0	2.6	3.2	3.2	2.9	1.9
	Relative risk	–	0.8	**1.0**	1.0	0.9	0.6
	Test to Total		$\chi^2 = 1.676$		P > .50	NS	
	Test to LSS		$\chi^2 = .629$		P > .80	NS	
53	Tongue						
	Observed	44	12	13	18	1	–
	Expected (total)*	(44.0)	10.3	13.4	18.6	1.7	–
	Expected (LSS sample)**	(44.0)	10.7	14.4	16.4	2.5	–
	Rate/10^5 (LSS) person-years	1.8	2.0	1.7	2.0	0.7	–
	Relative risk	–	1.2	**1.0**	1.2	0.4	–
	Test to Total		$\chi^2 = .792$		P > .80	NS	
	Test to LSS		$\chi^2 = 1.385$		P > .70	NS	

**Total: All sites combined, total cases (232)* 合計：全部位合計，全症例（232）

***LSS sample: LSS person-years (2,406, 609)* 寿命調査対象群：LSS 人年（2,406,609）

TABLE 10 STATISTICAL ANALYSIS OF CANCER OF THE ACCESSORY SINUS, EPIGLOTTIS AND LARYNX, AND TONGUE, SEXES AND CITIES COMBINED, DEFINITE CASES

表10　診断確実例の副鼻腔癌，喉頭蓋及び喉頭癌，舌癌の統計的解析（男女・両市合計）

SNOP Code	Site	Total	T65 Dose in rad				
			NIC	0	1-99	100+	Unk.
	All sites combined	154	36	43	65	6	4
22	Accessory sinus						
	Observed	38	8	5	20	2	3
	Expected (total)*	(35.0)	8.4	10.0	15.2	1.4	–
	Expected (LSS sample)**	(35.0)	8.5	11.5	13.0	2.0	–
	Rate/10^5 (LSS) person-years	1.5	1.4	0.6	2.2	1.4	5.5
	Relative risk	–	2.1	**1.0**	3.5	2.3	8.8
	Test to Total		$\chi^2 = 5.66$		P > .10	NS	
	Test to LSS		$\chi^2 = 7.44$		P = .06	Sug	
24	Epiglottis & Larynx						
	Observed	48	9	16	20	2	1
	Expected (total)*	(47.0)	11.3	13.5	20.3	1.9	–
	Expected (LSS sample)**	(47.0)	11.4	15.4	17.5	2.7	–
	Rate/10^5 (LSS) person-years	2.0	1.5	2.0	2.2	1.4	1.9
	Relative risk	–	0.8	**1.0**	1.1	0.7	0.9
	Test to Total		$\chi^2 = 1.382$		P > .70	NS	
	Test to LSS		$\chi^2 = 1.105$		P > .70	NS	
53	Tongue						
	Observed	29	10	8	10	1	–
	Expected (total)*	(29.0)	7.0	8.3	12.6	1.1	–
	Expected (LSS sample)**	(29.0)	7.1	9.5	10.8	1.6	–
	Rate/10^5 (LSS) person-years	1.2	1.7	1.0	1.1	0.7	–
	Relative risk	–	1.7	**1.0**	1.1	0.7	–
	Test to Total		$\chi^2 = 2.338$		P > .50	NS	
	Test to LSS		$\chi^2 = 1.776$		P > .62	NS	

**Total: All sites combined, definite cases (154)* 合計：全部位合計，全診断確実例（154）

***LSS sample: LSS person-years (2,406,609)* 寿命調査対象群：LSS 人年（2,406,609）

TABLE 11 TOTAL CASES BY RADIATION DOSE, CITY, AND SEX

表11　放射線量，都市，性別の全症例

	Total	T65 Dose in rad					χ^2 Test
		NIC	0	1-99	100+	Unk.	
			Hiroshima				
Male	104	22	40	40	1	1	
Expected	(103.0)	25.4	37.9	35.4	4.3		P > .30
Rate/10^5 PY	14.2	12.4	15.1	16.2	3.3	7.7	NS
Relative Risk	–	0.8	**1.0**	1.1	0.2	0.5	
Female	74	20	19	28	5	2	
Expected	(72.0)	17.2	27.3	24.6	2.9		
Rate/10^5 PY	6.7	7.7	4.6	7.5	11.6	10.6	P > .10
Relative Risk	–	1.7	**1.0**	1.6	2.5	2.3	NS
Total	178	42	59	68	6	3	
Expected	(175.0)	42.3	65.6	60.0	7.1		
Rate/10^5 PY	9.7	9.6	8.7	11.0	8.2	9.5	P > .50
Relative Risk	–	1.1	**1.0**	1.3	0.9	1.1	NS

→

TABLE 11 (Continued) 続き

	Total	T65 Dose in rad					χ^2 Test
		NIC	0	1-99	100+	Unk.	
			Nagasaki				
Male	31	8	5	15	2	1	
Expected	(30.0)	7.8	5.7	13.1	3.4		
Rate/10^5 PY	11.7	12.2	10.3	13.6	6.9	9.1	P > .80
Relative Risk	–	1.2	**1.0**	1.3	0.7	0.9	NS
Female	23	3	5	13	1	1	
Expected	(22.0)	5.3	3.9	10.5	2.3		
Rate/10^5 PY	6.5	3.6	8.2	8.0	2.8	9.2	P > .30
Relative Risk	–	0.4	**1.0**	1.0	0.3	1.1	NS
Total	54	11	10	28	3	2	
Expected	(52.0)	13.0	9.5	23.8	5.7		
Rate/10^5 PY	8.7	7.4	9.2	10.2	4.6	9.1	P > .50
Relative Risk	–	0.8	**1.0**	1.1	0.5	1.0	NS
			Cities Combined				
Male	135	30	45	55	3	2	
Expected	(133.0)	33.2	42.8	48.9	8.1		
Rate/10^5 PY	13.7	12.5	14.5	15.5	5.1	8.4	P > .20
Relative Risk	–	0.9	**1.0**	1.1	0.4	0.6	NS
Female	97	23	24	41	6	3	
Expected	(94.0)	22.5	31.1	35.2	5.2		
Rate/10^5 PY	6.7	6.8	5.1	7.7	7.6	10.2	P > .30
Relative Risk	–	1.3	**1.0**	1.5	1.5	2.0	NS
Total	232	53	69	96	9	5	
Expected	(227.0)	55.3	74.3	84.3	13.1		
Rate/10^5 PY	9.5	9.1	8.8	10.8	6.5	9.4	P > .30
Relative Risk	–	1.0	**1.0**	1.2	0.7	1.1	NS

TABLE 12 DEFINITE CASES BY RADIATION DOSE, CITY, AND SEX

表12 放射線量，都市，性別の診断確実例

	Total	T65 Dose in rad					χ^2 Test
		NIC	0	1-99	100+	Unk.	
			Hiroshima				
Male	67	18	22	26	0	1	
Expected	(66.0)	16.3	24.3	22.7	2.7		
Rate/10^5 PY	9.2	10.2	8.3	10.5	–	7.7	P > .30
Relative Risk	–	1.2	**1.0**	1.3	–	0.9	NS
Female	42	11	11	15	4	1	
Expected	(41.0)	9.8	15.6	14.0	1.6		
Rate/10^5 PY	3.8	3.5	3.1	4.0	9.3	5.3	P > .10
Relative Risk	–	1.1	**1.0**	1.3	3.0	1.7	NS
Total	109	29	33	41	4	2	
Expected	(107.0)	25.9	40.1	36.7	4.3		
Rate/10^5 PY	5.9	6.2	5.2	6.6	5.5	6.3	P > .50
Relative Risk	–	1.2	**1.0**	1,3	1.1	1.2	NS

→

TABLE 12 (Continued) 続き

	Total	T65 Dose in rad					χ^2 Test
		NIC	0	1-99	100+	Unk.	
			Nagasaki				
Male	25	5	5	13	1	1	
Expected	(24.0)	6.2	4.6	10.5	2.7		
Rate/10^5 PY	9.5	7.6	10.3	11.8	3.4	9.1	P > .50
Relative Risk	–	0.7	**1.0**	1.1	0.3	0.9	NS
Female	20	2	5	11	1	1	
Expected	(19.0)	4.6	3.4	9.0	2.0		
Rate/10^5 PY	5.7	2.4	8.2	6.8	2.8	9.2	P > .30
Relative Risk	–	0.3	**1.0**	0.8	0.3	1.1	NS
Total	45	7	10	24	2	2	
Expected	(43.0)	10.7	7.9	19.7	4.7		
Rate/10^5 PY	7.3	4.7	9.2	8.4	3.1	9.1	P > .20
Relative Risk	–	0.5	**1.0**	0.9	0.3	1.0	NS
			Cities Combined				
Male	92	23	27	39	1	2	
Expected	(90.0)	22.4	29.0	33.1	5.5		
Rate/10^5 PY	9.3	9.6	8.7	11.0	1.7	8.4	P > .10
Relative Risk	–	1.1	**1.0**	1.3	0.2	1.0	NS
Female	62	13	16	26	5	2	
Expected	(60.0)	14.4	19.9	22.4	3.3		P > .50
Rate/10^5 PY	4.3	3.8	3.4	4.9	6.3	6.8	NS
Relative Risk	–	1.1	**1.0**	1.4	1.9	2.0	
Total	154	36	43	65	6	4	
Expected	(150.0)	36.6	49.1	55.7	8.6		
Rate/10^5 PY	6.3	6.2	5.5	7.3	4.4	7.5	P > .30
Relative Risk	–	1.1	**1.0**	1.3	0.8	1.4	NS

Analysis of cases according to sex, city, and dose is shown in Table 11 for total cases, and Table 12 for definite cases. Cases with a T65D of 0 rad were assigned a relative risk of 1.0, and incidence expressed as rate per 10^5 persons per year. No significant increase in relative risk for combined cancer sites was found when cases were grouped according to sex or city for either the total or definite case category.

性，都市及び線量別の症例の解析を，全症例に関しては表11に，診断確実例に関しては表12に示す．T65Dが0 rad の症例を相対的危険度1.0とし，発生率は10^5人年当たりの比率で示した．全症例群及び診断確実例群の症例を性別あるいは都市別に分類した場合，全部位をひっくるめての相対的危険度には有意な増加は見られなかった．

DISCUSSION

The results of the present study provided no definite evidence of an increase in the incidence of cancer as a result of A-bomb radiation exposure for any of the head and neck sites surveyed (lip, nose and nasal cavity, accessory sinuses, larynx, and the oral cavity and pharynx with their subdivisions), considered either as a group or by individual site. Although a suggestive (P=.06) relationship to radiation dose was noted for histologically confirmed accessory sinus cancers, the paucity of observed cases in the

考　察

本調査の結果，調査した頭・頸部のいずれの部位（唇，鼻及び鼻腔，副鼻腔，喉頭，口腔及び咽頭とその細目）についても，原爆放射線被曝の結果として癌発生率の増加を示す明らかな証拠は全部位として考察しても，また，部位別に見ても，得られなかった．組織学的に確認された副鼻腔癌と放射線量との間に有意な関係（P＝.06）が示唆されたが，

0 rad group (5 observed vs 10.0 or 11.5 expected), the lack of increased relative risk with increased radiation dose, and the small number of cases in the 100+ rad group (2 observed vs 1.4 or 2.0 expected) render the data deficient and require that interpretation be made with caution. The reasons for the small number of cases observed in the 0 rad group are not clear. Generally the ratio of observed to expected cases was much closer to 1.0 for the other 0 rad groups (Tables 11 and 12) when analyzed by city and sex. In many of the groups, the number of cases were much larger, and it is recognized that with smaller numbers, the chance of introduction of error increases. The present results do not appear to justify the assumption that the incidence of sinus cancer is increased as a result of A-bomb irradiation, and further observation will be required for clarification in this group of tumors.

An association, however, between various types of radiation exposure and the subsequent development of neoplasms of the sites surveyed in this study has been reported by several investigators. Wynder et al,[27] in a retrospective survey of mouth, pharynx, and larynx cancer, reported an association between the occurrence of a second neoplasm following irradiation for a first neoplasm, particularly in male ex-smokers with a greater than 4-year lapse between diagnosis of the first neoplasm and appearance of the second. Court Brown and Doll,[28] in a review of mortality from cancer and other causes in patients with ankylosing spondylitis who had received spinal irradiation, observed a significant increase in the frequency of mortality from pharyngeal cancer over that expected, although the total number of cases was small (4 observed vs 0.7 expected). No significant increase in larynx cancer was found, however. The radiation exposure of the spinal marrow from radiotherapy for ankylosing spondylitis is reported to range from less than 500 to over 2,000 R.[29] Goolden[30] extensively reviewed cases of pharynx and larynx cancer from the world's literature which occurred following irradiation of the neck for thyrotoxicosis and tuberculous adenitis. Although reliable dose information in most cases is not available, the history of multiple treatments and presence of radiation sequelae such as characteristic skin changes and subcutaneous fibrosis left little doubt that the majority of the cases were radiation related. In the group of 3,000 patients irradiated for thyrotoxicosis at Manchester between 1912-23, the observed

0 rad 群で観察された症例が少ないこと（期待値10.0ないし11.5に対し観察例数５），放射線量の増加に伴う相対的危険度の増加が見られないこと，また，100rad 以上群中の症例数が少ないこと（期待値1.4ないし2.0に対し観察例数２）などのため，データとして不十分であり，解析には慎重を要する．0 rad 群において観察例数が少なかった理由は明かでない．全体的に見て，都市別及び性別に解析した場合の0 rad 群では全般的に観察例数対期待値の比は，1.0に更に近くなる（表11及び12）．多くの線量群において症例数はもっと多い．症例数が少ない場合，誤差を導入する機会が増加する．今回の調査結果では，副鼻腔癌の発生率が原爆放射線照射の結果増加するという仮説を立証できないと思われるので，この群の腫瘍を解明するためには更に観察を行うことが必要である．

とはいえ，各種の放射線被曝と本調査で調べたような部位の被曝後の新生物発生との関連性が幾つか報告されている．Wynder ら[27]は口腔癌，咽頭癌，喉頭癌に関する遡及的調査において，最初の新生物に対して行った放射線照射と第二の新生物発生との関連を報告している．特に以前に喫煙していた男性では，最初の新生物の診断から再発までの期間が４年以上であることを述べている．Court Brown と Doll[28]は強直性脊椎炎の患者で脊椎に放射線照射を受けた者に認められた癌その他による死因の調査において，咽頭癌による死亡は，その総例数は少ないが，頻度は期待値よりも有意に高いということを認めた（期待値0.7に対し，観察数は４）．しかし喉頭癌の有意な増加は見られなかった．強直性脊椎炎の放射線治療から脊髄が受ける放射線量は500R 以下から2,000R[29]以上までにわたると報告されている．Goolden[30]は世界中の文献から，甲状腺中毒症及び結核性リンパ節炎治療のため頚部に放射線照射を受けた後発生した咽頭癌及び喉頭癌の症例について広範に検討を行った．ほとんどの症例について信頼できる線量データは得られていないが，重複した治療歴があること，特徴的な皮膚の変化及び皮下線維症などのような放射線由来の後遺症が認められることなどから，症例中の大多数は放射線関連であることはほとんど疑う余地がない．1912年から1923年の間に Manchester で甲状腺中毒症の放射線治療を受けた3,000人の集団中，観察された咽頭癌の発生

incidence of carcinoma of the pharynx was more than 10 times greater than that expected. Littman et al,[31] in a review of over 5,000 cases involving therapeutic or occupational exposure to radium, identified 21 patients with carcinoma of the mastoid and 11 with malignant tumors of the paranasal sinuses. Exposure in these cases was from radium nuclide deposition in bone, with the majority of the bone tissue dose coming from alpha particle emission. The source of exposure of the paranasal sinus mucosa in these cases was thought to be due both to gaseous radium decay products, mostly radon, trapped in poorly ventilated sinuses, and alpha particle emission from deposited radium. Skeletal doses in the 11 paranasal sinus malignancies ranged from 3,143 to 25,701 rad. Doses to the mucosal epithelium of the sinuses, however, were substantially less and depended on tissue thickness, and estimates for individual cases could not be made. It has been estimated that for radium patients, the ratio of observed to expected was 100:1 for mastoid and paranasal sinus cancer.[32]

The radiation induced paranasal sinus cases described above differed from the accessory sinus cases described in the present series in several important respects. In addition to the differences between the two groups in total dose, as well as the duration and type of radiation exposure, there were differences in the histological types of tumors observed. In the series of Littman et al,[31] among the 11 paranasal sinus cases there were 4 mucoepidermoid carcinomas, 3 epidermoid carcinomas, 2 adenocarcinomas, 1 rhabdomyosarcoma, and 1 of unknown histology. Among the 38 definite cases of accessory sinus cancer in the present series, 34 were squamous cell carcinomas. In addition, there were two sarcomas and two adenoid cystic carcinomas. The exposure status for these latter four cases were NIC, 5 rad, 0 rad, and dose unknown, respectively. No case of mucoepidermoid carcinoma occurring in an accessory sinus was found in the present series of A-bomb survivors.

There have been several previous reports of individuals who received radiation exposure to the head and neck region in which no increased incidence of cancer in the sites surveyed in this report was observed. Modan et al,[33] and Shore et al,[34] in studies of children who had received X-ray therapy for tinea capitis, reported increased incidences of skin, brain, thyroid, and parotid

率は，期待値より10倍以上高かった．Littman ら[31]は治療上あるいは職業上のラジウム被曝を含む5,000例の調査において，乳様突起の癌患者21人及び副鼻腔の悪性腫瘍患者11人を確認した．これらの症例における被曝はラジウムの核種が骨に沈着したことによるもので，骨の組織線量の大部分はアルファ粒子の放出により生じたものであった．これらの症例における副鼻腔粘膜の被曝源は，換気不良の副鼻腔でつかまえられたガス状ラジウム崩壊物質（多くはラドン）と沈着したラジウムから放出されるアルファ粒子であると思われた．副鼻腔の悪性腫瘍11例における骨格線量は3,143rad から25,701rad の範囲であった．しかしながら，副鼻腔の粘膜上皮の線量は実質的にはこれ以下で組織の厚さに影響されるので，個々の症例に対する推定値は得られなかった．ラジウム患者については，乳様突起癌及び副鼻腔癌の観察例数対期待値の比率は100：1であると推定されている．[32]

上述した放射線誘発性副鼻腔癌の症例は，本報で述べている副鼻腔癌の症例とは幾つかの重要な点で差異がある．二つの症例群に総線量，放射線被曝の期間と種類に差異が見られるのに加えて，観察された腫瘍の組織型に差異がある．Littman らの調査例においては，[31]副鼻腔癌11例のうち，粘表皮癌４例，類表皮癌３例，腺癌２例，横紋筋肉腫１例及び組織型不明１例であった．本調査例では副鼻腔癌の診断確実の38例のうち34例が扁平上皮癌であった．これに加えて肉腫２例，腺様嚢胞癌２例があった．この４症例の被爆状態はそれぞれ，NIC，５rad，０rad，及び線量不明であった．本調査例における原爆被爆者には副鼻腔に粘表皮癌が発生した症例は認められなかった．

頭・頚部領域へ放射線照射を受けた人に関する報告がこれまでに数例あるが，その中では本報告で調べたような部位の癌発生率の増加は認められない．Modan ら[33]及び Shore ら[34]は頭部白癬の放射線治療を受けた子供を調査し，皮膚，脳，甲状腺及び耳下腺の腫瘍の発生率増加を報告したが，その他の部位

gland tumors, but not of other sites. Estimated doses received were about 400 rad to the cranial marrow, 70-175 rad to the brain, and about 6 rad to the thyroid.[34] Soloway[35] reviewed 22 published cases of radiation-related neoplasms following curative therapy for retinoblastoma and added three cases of his own. The majority were osteogenic sarcomas and fibrosarcomas, with three cases of skin carcinoma. Doses reported were above 8,000 R in the majority of cases, so that the scatter dose to surrounding tissues was probably substantial. None of the reported cancers occurred in sites surveyed in the present report. Hempelmann et al,[36] and Janower and Miettinen,[37] in studies of neoplasms following childhood irradiation for thymic enlargement, noted definite increases in the incidence of thyroid neoplasms, but not of other head and neck sites. Radiation doses depended largely on age, but were generally in the range of 100-600 R.

Although the exposure history of A-bomb survivors differs significantly from that of most of the other groups described above, it is of interest to note that in series of patients treated for thymus enlargement[36,37] and tinea capitis[33,34] increased incidences of thyroid and salivary gland tumors have been observed; tumors from these sites have also been found to be radiation related in A-bomb survivors.[11,12,19,20] These groups share in common the fact that relatively low doses were incurred. Among A-bomb survivors about 65% of the assigned T65D total dose estimates are below 10 rad.[38] Previous reports of radiation-related increases in the incidences of the sites surveyed in this study were found in groups of patients who received relatively high doses to the sites at risk. This may indicate that substantially higher doses are required for the radiation induction of tumors at these sites, similar to that observed for osteogenic and other types of sarcomas, which also are usually found following relatively high therapeutic radiation exposures. No radiation-related increase in sarcomas has yet been found from studies of A-bomb survivors.

Another factor of possible relevance is the possibility of a relatively lengthy induction time for at least some of these tumors. Littman et al[31] recorded a median induction time of 33-34 years for their group of radium-induced mastoid and paranasal sinus malignancies. The study of A-bomb survivors continues to reveal an increas-

には増加を見ていない．受けた推定線量は頭蓋骨髄が約400rad，脳が70－175rad，甲状腺が約6 radであった．[34] Soloway[35]は網膜芽腫治療後に発生した放射線関連新生物の既報22例に関して検討し，これに彼自身が調査した3例を加えた．そのうちで多いのは骨肉腫と線維肉腫で，皮膚癌は3例であった．報告された線量は大部分の症例で8,000R以上なので，周囲組織への散乱線量も相当高いものと思われる．この報告された癌のうち本報告で調べた部位に発生したものはなかった．Hempelmannら[36]及びJanower と Miettinen[37]は，幼年期に胸腺肥大のため放射線治療を受けた後発生した新生物に関して調査し，甲状腺新生物の発生率に明らかな増加を認めたが，その他の頭・頸部については癌発生率増加を認めていない．放射線量は年齢に大きく影響されるが，概して100－600Rの範囲であった．

原爆被爆者の被曝歴は上述したほかの群の大部分のそれとは著しく異なるが，胸腺肥大[36,37]及び頭部白癬の治療を受けた患者群において，甲状腺腫瘍及び唾液腺腫瘍の発生率に増加が見られたことは興味深いことである．これらの部位の腫瘍は原爆被爆者においても放射線関連であると認められている．[11,12,19,20] 上記の2群は，比較的低線量に被曝したという事実を共有している．原爆被爆者に与えられたT65D総線量推定値の約65％が10rad以下である．[38]本研究の調査部位における癌発生率の放射線との関連的増加に関する従来の報告は，対象部位にかなり高線量を受けた患者群で認められたものである．このことは，これらの部位における腫瘍の放射線誘発には実質的に高い線量が必要であるということを示している．これは骨肉腫及びその他の種類の肉腫と同様であり，通常肉腫もまたかなり高い治療用放射線被曝後に発生する．原爆被爆者の調査からは放射線誘発性肉腫の増加はまだ認められていない．

両群の関連性を示すと思われるもう一つの因子は，少なくともこれらの腫瘍の幾つかには比較的長い誘発期間がある可能性があることである．Littmanら[31]はラジウム誘発の乳様突起悪性腫瘍及び副鼻腔悪性腫瘍の誘発期間の中央値を測定し，33－34年と記録している．原爆被爆者の調査は幾つかの充実性腫瘍の発生の増加を示し続けており，原爆放射線の発癌

ing incidence of some solid tumors,[39] and it is expected that continued observation well into the future will be required to fully elucidate the carcinogenic as well as any other potential effects of atomic radiation.

効果とその他の潜在的効果を完全に解明するためには遠い将来まで観察を継続する必要がある.

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APPENDIX I MF NUMBER OF HISTOLOGICALLY CONFIRMED CASES OF HEAD AND NECK CANCER

付録1 組織学的に確認された頭・頚部癌症例の基本名簿番号

HIROSHIMA

Male

[redacted]

Female

[redacted]

NAGASAKI

[redacted]

Female

[redacted]