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Radiologic Assessment of Resectability and Prognosis in Esophageal Carcinoma

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Abstract. Utilizing double-contrast technique it is possible to detect the earliest malignant lesions of the esophagus even when the carcinoma is confined to the mucosa. In patients with carcinoma, it is also important to attempt to grade and classify the lesion in order to predict its resectability and prognosis. The resectability of a lesion is determined by the depth of invasion and by the presence or absence of lymph node metastases. The significant factors are the length of the lesion, its gross morphology, the character of its margins, and the depth of ulceration. Unfortunately, the depth of invasion is not necessarily directly related to the prognosis. In some carcinomas confined to the submucosa, lymph node metastases are already present, and these patients have a poor prognosis. The presence of lymph node metastases in early carcinoma can be suggested by the gross morphology of the lesion, its length, irregularity of the surface, and the presence of a complex lesion. Careful analysis of the radiographic features of the carcinoma can be valuable for the assessment of resectability and prognosis.

Key words: Carcinoma of the esophagus, resectability.

The operative mortality of patients with carcinoma of the esophagus has decreased from 95% in 1930 to 4.3% in 1975 in our hospital [1]. The improved survival can be ascribed to improvements in surgical technique and postoperative care. The 5-year survival rate of patients treated by combination therapy of operation, radiation and chemotherapy has also improved from 13.5% prior to 1965 to 21.5% today.

There are two stages to the radiologic assessment

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Table 1. Relationship between invasion to adventitia and 5-year survival rate

Invasion to adventitia		No. of cases	No. of 5-year survivors	5-year survival rate (%)
No invasion	(a_0)	34	13	38.2
Invasion reaching the adventitia	(a_1)	35	15	42.8
Definite invasion	(a_2)	94	19	20.2
Invasion of neighboring structures	(a_3)	76	1	1.3

Table 2. Relationship between lymph node metastases and 5-year survival

Lymph nodes involved	No. of patients	5-year survivors	Rate (%)
None $N_0(-)$	18	9	50
Regional $N_1(+)$	64	21	32.8
Surrounding area $N_2(+)$	70	15	21.4
Distant $N_3(+)$	39	3	7.6

Table 3. Relationship between grade of invasion and radiologic types

Depth of invasion	Superficial	Polypoid	Serrated	Spiral	Funneled
Mucosa, submucosa (a_0)	19	15	2		
Muscularis propria (a_0)	2	13	26	2	1
Reaching the adventitia (a_1)		9	32	1	
Invading the adventitia (a_2)		9	63	59	7
Invading neighboring structures (a_3)		3	25	52	10

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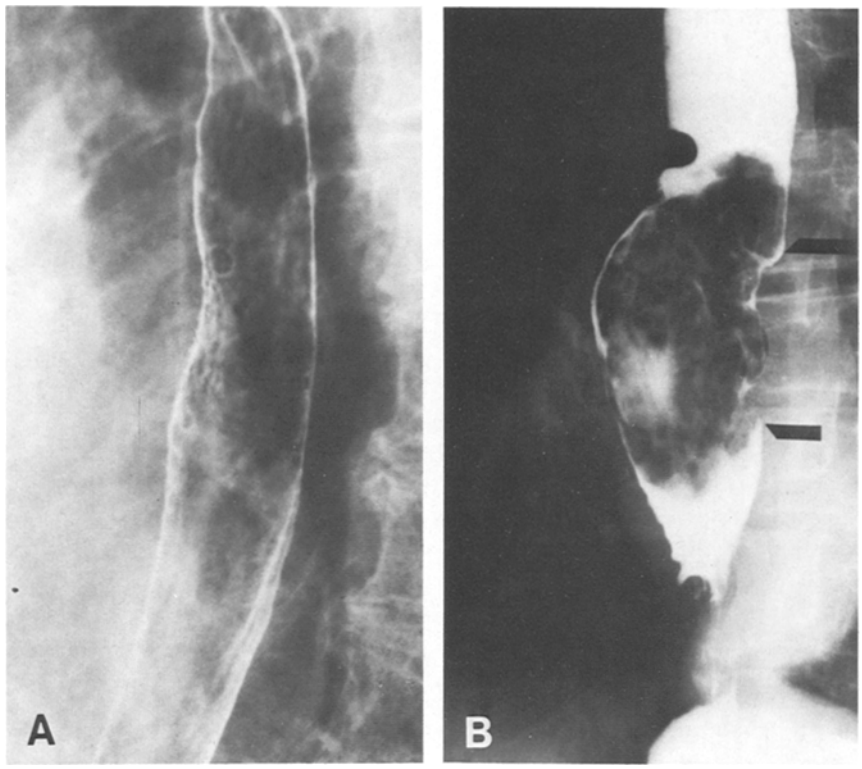

Fig. 1 A and B. Classification of esophageal carcinoma.
A Superficial flat type. Double carcinoma with advanced stomach carcinoma. X-ray shows cessation of the relief 6 cm long and irregular and granular coarseness of the lesion in the mid-thoracic esophagus. Depth of invasion: muscularis mucosae
B Polypoid type. The filling defect of tumorous type is seen in the mid-thoracic esophagus. The surface is nodular. The lesion seems to be advanced carcinoma, but is in fact a semipeduncular one whose base is indicated by an arrow. The infiltration is limited within the submucosal layer

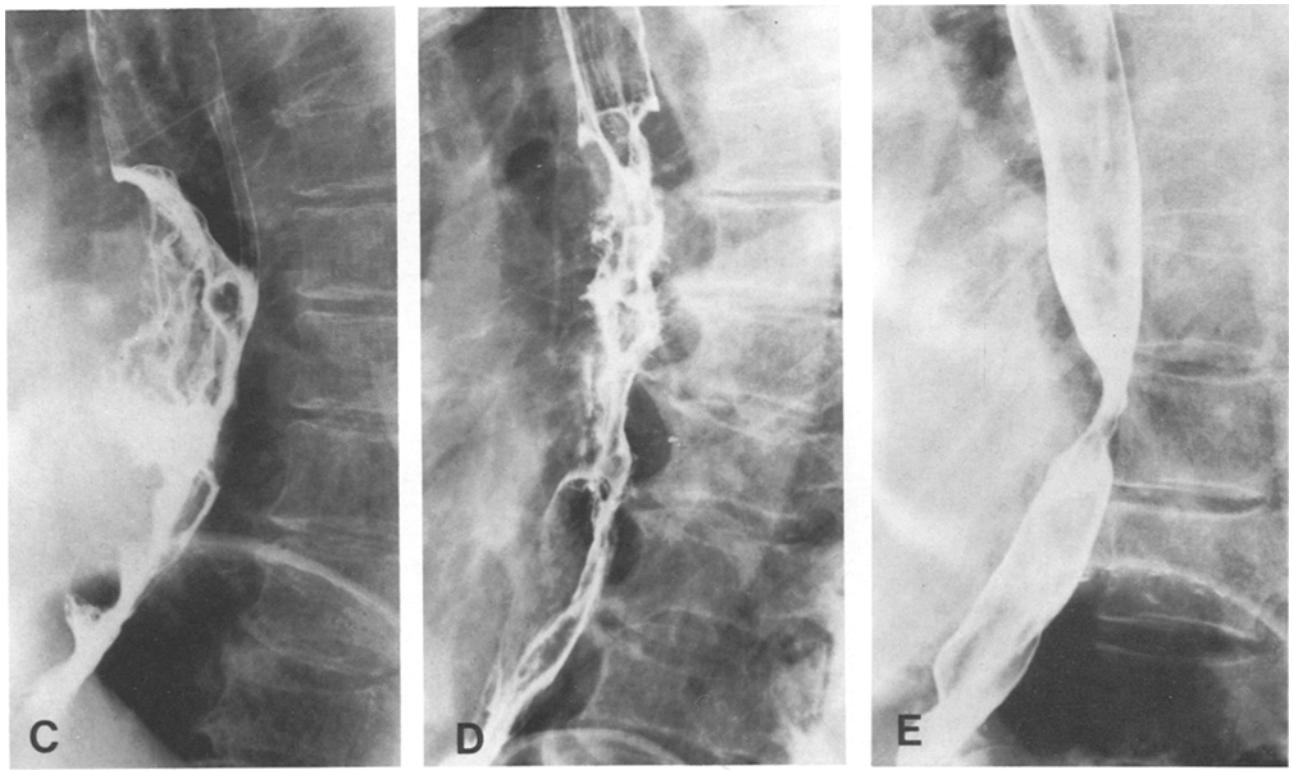

Fig. 1 C. Serrated type (eccentric ulcerated). This is a well-defined a_3 carcinoma. The ulcer of single type is deep beyond the margin of the esophagus. The patient underwent operation after 2400 rads of irradiation in total. After 5 years the patient remains alive. **D** Spiral type (annular with ulceration). The bilateral filling defect is seen in the mid-thoracic esophagus, and infiltration extends to the lower esophagus. This is a case of moderately defined a_2 carcinoma. The bottom of the ulcer is irregular but not rigid, and this case belongs to spicular type. The patient underwent operation after preoperative irradiation of 6200 rads in total. The patient lived more than 5 years. **E** Funneled type (smoothly tapered). Short bilateral filling defect is seen in the mid-thoracic esophagus

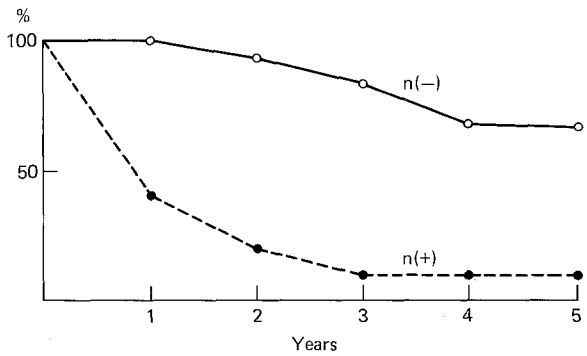

Fig. 2. Long term survival rate. Relationship between n(−) and n(+) of SM carcinoma of the esophagus

Table 4. Radiologic types and lymph node metastases of SM carcinomas

	No. of cases	N(−)	N(+)
Superficial flat			
Single	4	4	0
Complex	2	2	0
Superficial depressed			
Single	7	5	2
Complex	2	0	2
Superficial elevated			
Single	4	4	0
Complex	2	2	0
Tumorous elevated			
Single	7	5	2
Complex	3	0	3
Tumorous			
Single	3	3	0
Complex	2	1	1
Unclassified	1	0	1

of patients with esophageal carcinoma. The first objective is to detect the tumor in its earliest stages [2, 3]. Once the lesion is detected, the radiologic examination should be directed towards determination of the depth of invasion and the presence or absence of lymph node metastases since these determinations will dictate the method of treatment.

The data presented in this paper are taken from our experience with 239 patients with carcinoma of the esophagus seen at the Institute of Gastroenterology, Tokyo Women's Medical College.

Determination of Prognosis in Surgical Cases

Tables 1 and 2 show clearly the deterioration in prognosis with progressive depth of invasion by the tumor (Table 1) and with the presence of more distant lymph node metastases (Table 2).

Clearly, in order to determine resectability of a lesion it is important to assess the depth of invasion. Therefore, it is important to consider whether there are any radiologic features which would allow for determination of the depth of invasion. The Japanese Society of Esophageal Diseases (JSED) has adopted the following classification of esophageal carcinoma [4]:

1. Superficial (Fig. 1 A)
2. Polypoid (Fig. 1 B)
3. Serrated (eccentric ulcerated) (Fig. 1 C)
4. Spiral (annular with ulceration) (Fig. 1 D)
5. Funneled (smoothly tapered) (Fig. 1 E).

Table 3 shows the relationship between the morphologic type of esophageal carcinoma and the depth of invasion. It can be seen that almost all of the

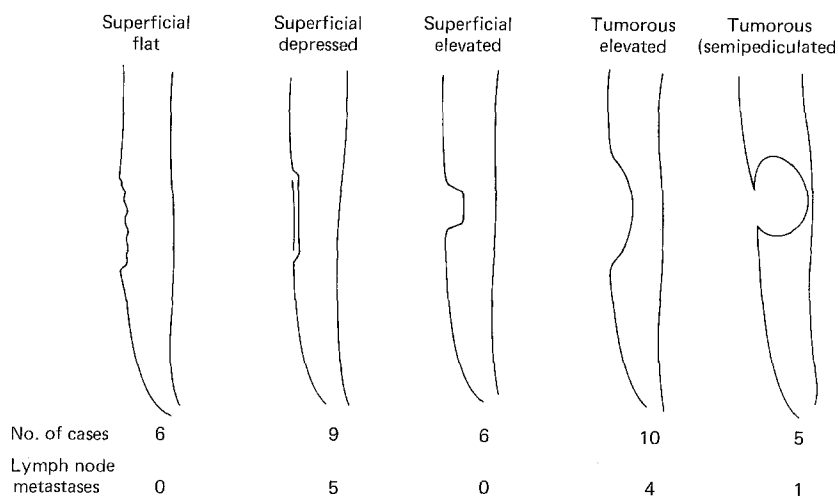

Fig. 3. Radiologic types of SM carcinoma

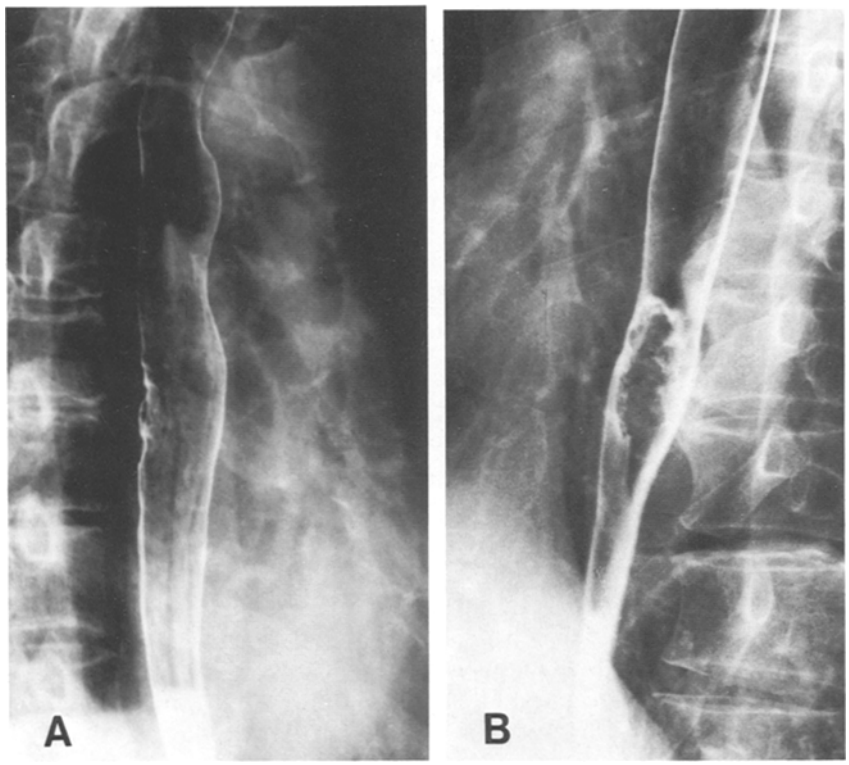

Fig. 4. Types of SM carcinoma.
A Superficial depressed type. A well-defined round filling defect is seen at the mid-thoracic esophagus. The bottom is irregular. Depth of invasion: submucosal layer. Lymph node metastasis (−); vascular invasion (+)
B Tumorous elevated type. The oval filling defect 4 cm in length is seen in the mid-thoracic esophagus. The surface is coarse but there is no ulcer. Depth of invasion: submucosal layer. Lymph node metastasis (−); vascular invasion (−)

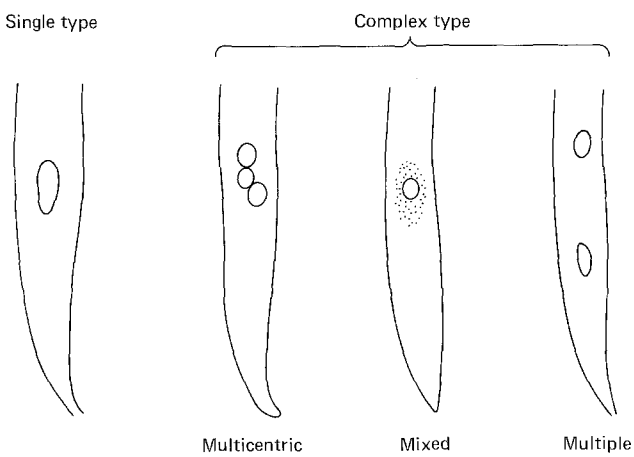

Fig. 5. Radiologic types of SM carcinoma: single and complex

superficial-type lesions and approximately half of the polypoid lesions were confined to the submucosa. At the other end of the spectrum, almost one-half of the annular ulcerated lesions and more than one-half of the smoothly tapered lesions were found to be invading into neighboring structures and were therefore unresectable. We also found that there was a correlation between extent of invasion and the length of the lesion. Only 1 of 14 cases in which the lesion was less than 4 cm was in the a_3 stage whereas more than half of the lesions over 10 cm in length were a_3.

It may be difficult to distinguish on radiological grounds between a_2 and a_3 tumors. There are no radiologic findings which can be used to distinguish absolutely. However, a_3 tumors tend to be annular, have ill-defined margins, deep ulceration, and a length greater than 8 cm. Using these criteria, it is possible to make a correct diagnosis of a_3 in 70% to 80% of cases.

Determination of Prognosis from X-Ray Findings

Until now, we have been discussing the relationship between the radiologic findings and the depth of invasion. This determines the resectability of the tumor, but the depth of invasion does not necessarily parallel the prognosis. We will therefore discuss the relationship between the radiologic findings and prognosis in early and superficial carcinoma.

The term "sm carcinoma" is applied to tumors in which the infiltration is limited to the submucosal layer. If there is no lymph node metastasis we use the term "early carcinoma," and when there are lymph node metastases we use the term "superficial carcinoma." Thus far, 101 cases of early esophageal carcinoma have been reported in Japan. In our hospi-

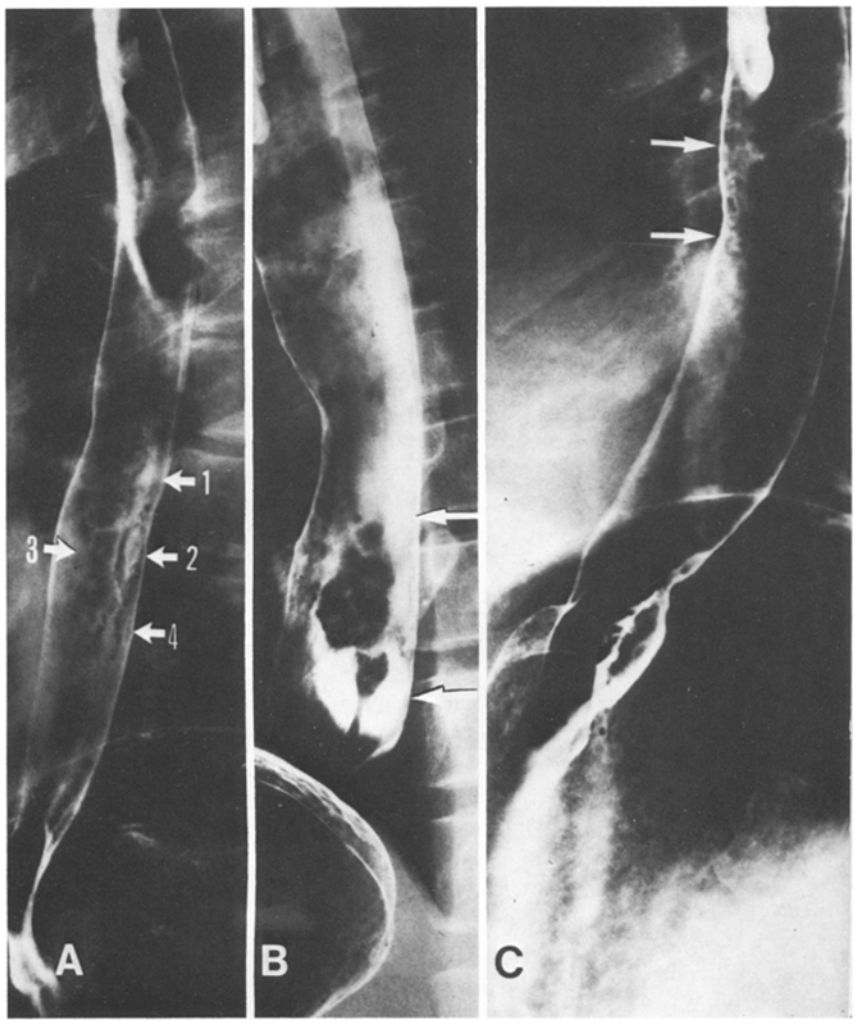

Fig. 6. SM carcinoma, complex type. **A** 4 superficial depressed lesions are seen at the mid-thoracic esophagus. **B** 3 elevated lesions of superficial protruded type are seen from the lower thoracic esophagus to the abdominal esophagus. The compressed picture of the anterior wall of the mid-thoracic esophagus is due to metastatic lymph node enlargement. **C** The filling defect of serrated type 4 cm in length is seen at the abdominal esophagus. The preoperative diagnosis of advanced carcinoma was made erroneously. The double-contrast picture in LAO position shows slightly irregular margin and granular lesion at the anterior wall of the mid-thoracic esophagus. This lesion could be read retrospectively after operation. In almost all complex types, even if depth of invasion is limited within the submucosal layer, lymph node metastasis is seen and therefore the prognosis is very poor

tal, our experience consists of 26 patients with early carcinoma and 11 patients with superficial carcinoma. The early carcinomas account for 3.6% of all esophageal carcinomas in our hospital.

The 5-year survival rate for early carcinoma has been 67%, and in patients with superficial carcinoma it has been 17% (Fig. 2). The latter is similar to the average 5-year survival of all patients with esophageal carcinoma. Therefore, the prognosis of sm carcinoma is determined by the presence or absence of lymph node metastases rather than by the depth of invasion. We also found that cases with vascular invasion had a 36% recurrence rate. Therefore, from a prognostic point of view it would be valuable to be able to detect the presence of vascular invasion or lymph node metastases in patients with sm-carcinoma.

The 37 cases of sm-carcinoma were classified with respect to their gross morphology (Fig. 3) as either superficial flat, superficial depressed (Fig. 4A), superficial elevated, tumorous elevated (Fig. 4B), or polypoid (semipedunculated). One of the cases was unclassified. All cases of superficial flat and superficial elevated lesions were early carcinomas without lymph node metastases, although there was lymphatic vessel invasion in 50% of the cases. Approximately 50% of patients with tumorous elevated and superficial depressed lesions had lymph node metastases. In the semipedunculated group, only one patient had lymph

Table 5. X-ray types and survival rates in a_2 and a_3 carcinomas[a]

	No. of cases	~6 month	~1 year	~2 years	~3 years	~4 years	4 years~
Tiny ulcerative							
Resected	56	7	9	24 (5)	3	3	10 (5)
Nonresected	60	23	17	13 (2)	4		3 (1)
Ulcerative							
Resected	166	31	42 (2)	47 (5)	23 (10)	9 (8)	14 (14)
Nonresected	187	111	48 (1)	23 (4)	4 (1)	1	
Tumorous scirrhous							
Resected	8	5	2	1			
Nonresected	7	4	2	1			
Infiltrating							
Resected	9	4	4	1			
Nonresected	9	5	3	1			

[a] Numbers in parentheses indicate patients still alive

node metastases and another patient had lymphatic invasion. Both of these tumors were carcinosarcomas.

The cases of sm carcinoma can be further divided into the single or the complex type (Fig. 5). The single type refers to those cases in which there is only one lesion (Fig. 4). The complex type refers to any one of three subtypes:

1. Multicentric which is a collection of similar lesions.
2. Mixed type, consisting of a collection of different types of lesions. This occurs most commonly when the main lesion is surrounded by a superficial flat lesion. This corresponds to a superficial spreading type of carcinoma.
3. Multiple type, with several lesions apart from the main lesion, e.g., multiple carcinomas or intramural metastases (Fig. 6).

Invasion of blood vessels and lymphatic vessels was frequently seen in patients with early carcinoma. Lesions less than 3 cm in length usually had no lymph node metastases even if there was lymphatic vessel invasion, but if the main lesion was more than 3 cm in size, we could not evaluate the presence of lymph node metastases.

Irregularity of the surface of the lesion indicates a possibility of lymphatic invasion, whereas a smooth surface suggests that there is no lymphatic vessel invasion.

Relationship Between Prognosis and X-Ray Findings in a_2 and a_3 Carcinoma

Cases which were staged as a_2 or a_3 carcinoma on radiologic grounds were subdivided according to the gross morphology of the lesions as tiny ulcerative, ulcerative, tumorous scirrhous, or infiltrating. The survival of these patients is given in Table 5 with separate statistics for patients undergoing resection and those in whom resection was not carried out. In general, the survival is best in the resected patients; however, the prognosis in the tumorous scirrhous and infiltrating groups is very poor as no patient survived for more than 2 years.

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