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CERVICAL ESOPHAGEAL INDENTATION

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頸部食道にみられる切れ込み像について

原爆傷害調査委員会放射線部

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これまで頸部食道は，バリウム塊の通過が早いため，透視撮影による評価が困難であることが多かつた．しかし，映画撮影法の発達によってその点はきわめて容易になつている．

上部胃腸管X線検査を受けた90人について，16mm 映画撮影法により，頸部食道を調べた．このうちのほとんど全例が上部食道については愁訴はなかつた．

映画撮影法 で調べた 90例のうち， 8 例には，esophageal web が認められ，62例には postcricoid

impression（切れ込み），60例には変形性脊椎症の
突起による切れ込みがあり，また10例には輪状咽
頭筋肥大が認められた．

被検者中数例にみられた典型像および文献的考
察の結果を供覧する．

INTRODUCTION

Detailed examination of the entire esophagus is extremely important.　Due to the rapid passage of
the barium bolus, observation of the pharyngoesophageal junction during fluoroscopy was difficult.
Until the development of cinefluorography, results of precise cinefluorographic observations of the upper
esophagus have rarely been reported.

In 1939 Waldenstrom and Kjellberg[33] first reported upper esophageal webs as typical radiologic
findings of sideropenic dysphagia.　These webs have become a well-known radiological characteristic
of the so-called Plummer-Vinson syndrome.

Pitman and Fraser (1964)[25], found irregular impressions in the barium near the anterior esophageal
wall behind the cricoid cartilage which changed in shape during deglutition.　They attributed them to
the esophageal venous plexus and regarded them as distinct from esophageal webs.　This entity has
never been reported in Japan.　Impressions in the barium near the posterior wall are caused by
cricopharyngeal hypertrophy and vertebral osteophytes.　Cricopharyngeal hypertrophy results from
failure of the cricopharyngeus muscle to relax during deglutition.　Its peculiar shape is probably due to
neuromuscular dysfunction.　Dysphagia from esophageal compression by osteophytes of cervical ver-
tebrae was first reported in 1926[21].

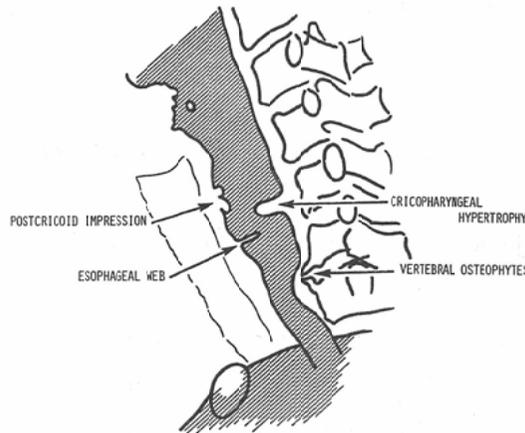Fig. 1 illustrates the typical appearances of these four types of indentations.

Fig. 1.　Esophageal indentations.

The frequency of these impressions has not been well established.　Their clinical significance lies in
differentiating them from postcricoid cancer.　We performed upper gastrointestinal (GI) series on 90
patients, using spot filming and 16 mm cinefluorography, and the results are reported here.

MATERIALS AND METHOD

Subjects

The cervical esophagi of 90 subjects referred by the outpatient clinic to the Department of

Radiology of the Atomic Bomb Casualty Commission (ABCC) for upper GI series were cinefluoro-graphically examined. All of the subjects were participants in the ongoing ABCC-JNIH (Japanese National Institute of Health) Adult Health Study (AHS) program[1], for the detection of late effects of exposure to the ionizing radiation of the atomic bombs. The upper GI series were performed because of symptoms, signs, or laboratory abnormalities detected during the course of clinical examinations. The subjects of the present study were largely asymptomatic with respect to their cervical esophagi.

Forty males and 50 females received esophageal (16 mm) cinefluorography. Their mean age was 56 years. Six had dysphagia; the others were free of esophageal symptoms.

Method of Study

A General Electric Fluoricon 150 kVp, 500 mA fluoroscopy-radiography unit with a 6–9 inch image intensifier, and 875-line closed-circuit television and mirror systems was used. A 16 mm syn-chronous cine camera and 5 cm width video-tape recorder with foot-switch control were incorporated. The cassette transport and radiographic apparatus were separate, the cassette being transported to the predetermined site for spot-film exposures the instant the manual exposure switch was closed.

The camera speed was variable from 7.5 to 60 frames per second, but 30 or 60 frames per second were usually used. For cinefluorography Eastman Kodak Plus-X negative film ♯ 7231 was exposed in the posteroanterior (PA) and lateral projections, and processed in an Eastman Kodak X-Omat M4A 90-second automatic processor.

The cine films were studied using a Kodak Analyst movie projector, whose remote control switch permitted speed variations from one frame per second to continous projection in forward or reverse directions, and "stills."

RESULTS

The distribution of subjects by deformity and sex is shown in Table 1. Postcricoid impressions were demonstrated in 62 cases; vertebral indentations, in 60 (Table 1). Forty-three of these 60 subjects had both vertebral osteophytic and postcricoid impressions. Cricopharyngeal hypertrophy was found in 10 cases, 7 of whom also had vertebral osteophytic indentations.

Among the 90 cases examined during 1 year, 6 esophageal webs were detected. Two additional esophageal webs were detected earlier[17]. All but one of the 8 webs were in females. No pre-ponderance by sex was noted for postcricoid or vertebral osteophytic impressions.

Prevalence of indentations did not increase by decade—even osteophytic indentations—though predominance of cricopharyngeal hypertrophy in older subjects was suggestive.

Table 1. Cervical esophageal indentations by sex in 90 subjects

	Male	Female	Total	Percent
Postcricoid	28	34	62	69%
Vertebral osteophytes	27	33	60	67
Cricopharyngeal hypertrophy	6	4	10	11
Esophageal web*	0	6	6	6.7

*This excludes two previously reported cases[17].

Table 2.　Esophageal indentations by age

	Average age (yrs.)	Age					
		30–39	40–49	50–59	60–69	70–79	80+
Total Subjects	56	6	24	18	26	15	1
Postcricoid	57	6	16	10	19	10	1
Vertebral osteophytes	57	3	14	13	18	11	1
Cricopharyngeal hypertrophy	65	0	1	2	3	4	0
Esophageal web*	62	0	0	3	2	1	0

*This excludes two previously reported cases[17].

CASE REPORTS

CASE I　(M.F. ♯ 207530)　Esophageal Web, Marked

This 56-year-old Japanese female, previously reported[17], had a typical marked esophageal web. An annular constriction at the pharyngoesophageal junction had been observed since 1959, and an upper GI series on October 11, 1972 showed no interval change (Figs. 2 A, B).　Dysphagia was nearly
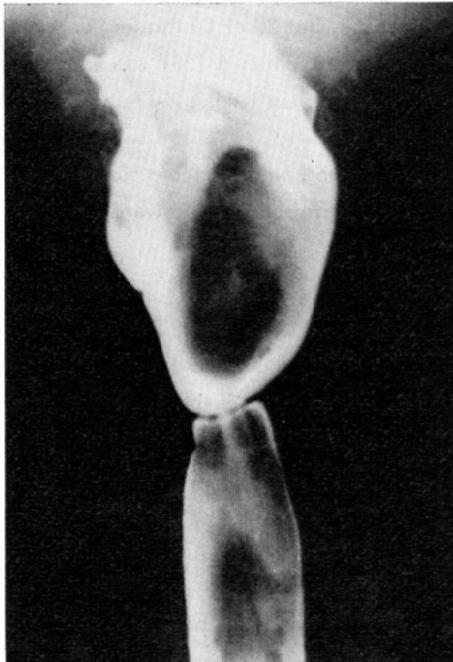

Fig. 2.　CASE I. (A) Posteroanterior view of an annular constriction.　Typical appearance of circular web with jet phenomenon.
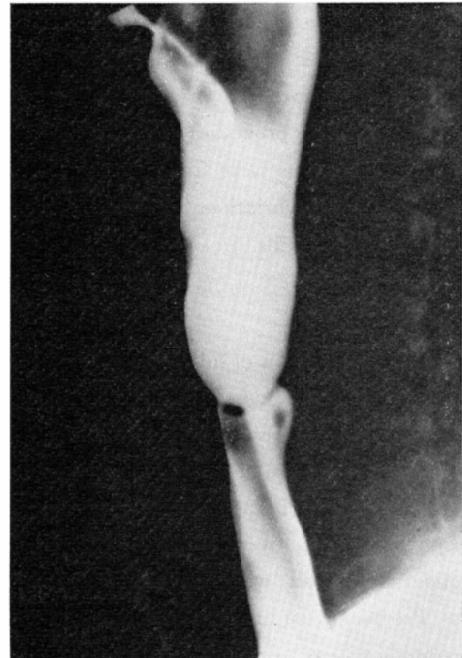
Fig. 2.　CASE I.　(B) Lateral view of the same circular web.　This web has been present for 13 years without definite interval change.

continuous for about 21 years.　Previously, spooned-finger nails and moderate hypochromic anemia were observed.　Hematology of March 27, 1973 revealed a red blood cell count (RBC) of $4.66 \times 10^6/mm^3$ and hemoglobin (Hb) of 13.8 g/dl.

CASE II　(M.F. ♯ 246168)　Esophageal Web, Moderate

A 68-year-old Japanese female with nontoxic diffuse goiter was examined with barium swallow.

She denied dysphagia. Hematology of April 10, 1973 showed a mild hypochromic anemia (RBC $4.09 \times 10^6/mm^3$, Hb 11.5 g/dl). Serum iron was 43; unsaturated iron-binding capacity (UIBC), 319 mg/dl; and the total iron-binding capacity (TIBC) was 362 mg/dl.

In the PA projection, in the cervical portion of the esophagus, there was a thin linear transverse filling defect at the pharyngoesophageal junction (Fig. 3A). This appeared as a thin indentation at right angles to the anterior wall in the lateral projection (Fig. 3B).

Fig. 3. CASE II. (A) A moderate esophageal web in the posteroanterior projection. Note the transverse linear filling defect in the region of the pharyngoesophageal junction.
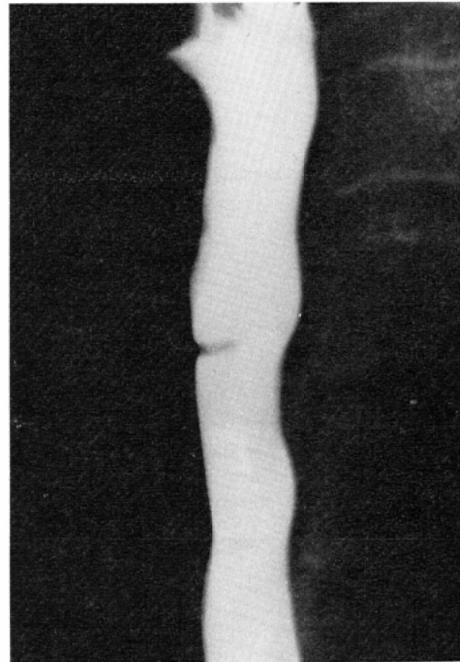
Fig. 3. CASE II. (B) Lateral view of the same web. The web is very thin and projects half-way into the lumen.

CASE III (M.F. # 283322) Esophageal Web, Minimal

A 74-year-old nondysphagic Japanese female had an upper GI series on May 28, 1973, which revealed a small thin filling defect in the barium near the anterior wall of the esophagus just below the cricoid cartilage in the lateral projection (Fig. 4). Slight anemia was observed in 1959, but hematology on May 14, 1973 revealed a RBC of $4.28 \times 10^6/mm^3$, and Hb of 12.0 g/dl.

CASE IV (M.F. # 326402) Postcricoid Impressions

A 44-year-old nondysphagic Japanese female received an upper GI series on May 29, 1972. An irregular indentation was noted in the barium near the anterior esophageal wall in the postcricoid

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NOTE: Normal ranges for this laboratory:

Red Blood Cell Count: 4.00–4.50 ($\times 10^6/mm^3$), female; 4.50–5.00 ($\times 10^6/mm^3$), male.

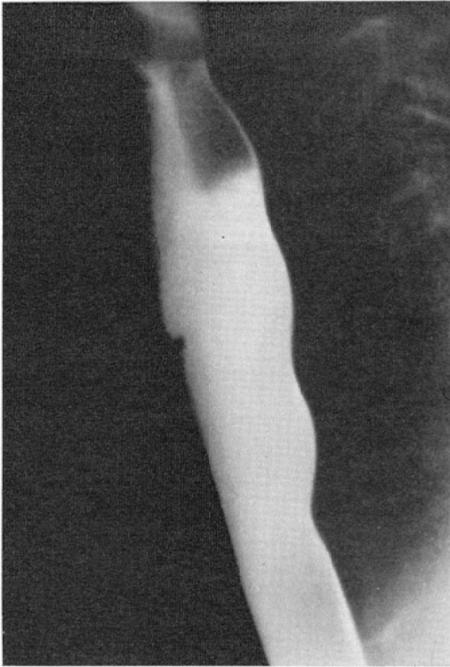Hemoglobin Concentration: 12.0–14.0 g/dl, female; 15.0–16.0 g/dl, male.

Fig. 4.　CASE III.　A small web in the lateral projection.　These are sometimes difficult to differentiate from postcricoid impressions.

Fig. 5.　CASE IV.　(B) Note the change in shape of the indentation during deglutition. The inferior impression resembles a small web from which it is impossible to differentiate.
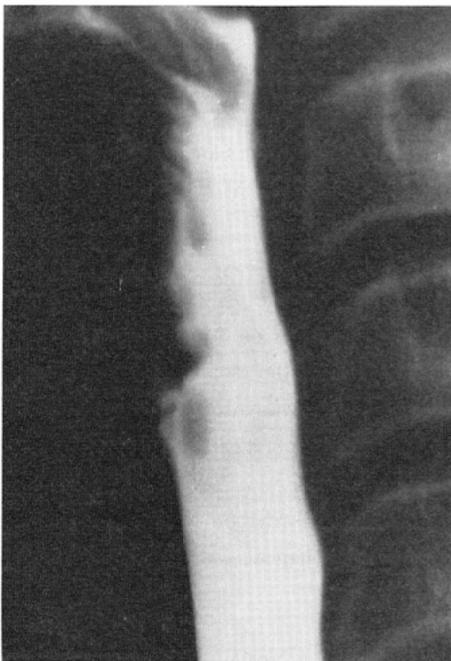

Fig. 5.　CASE IV.　(A) Postcricoid impression in the lateral projection.　Note the prominent irregular indentation.

Fig. 5.　CASE IV.　(C) After the barium bolus passes, no indentation can be seen.

region (Fig. 5A).   During deglutition this changed its form (Figs. 5B, C) and a lateral roentgenogram made just after barium passed the pharyngoesophageal junction revealed no definite defect.   We could not exclude the possibility of postcricoid carcinoma.   Hematology on April 24, 1972 showed an RBC of $4.20 \times 10^6/mm^3$, and a Hb of 12.1 g/dl.   Reexamination in July and September of 1972 showed no interval change.   At clinical follow-up in July 1973, the patient denied any symptoms associated with deglutition.

CASE V   (X 4210)   Postcricoid Impressions and Cricopharyngeal Hypertrophy

An additional patient, a 54-year-old Caucasian male not in the AHS sample, who was examined by upper GI series on December 16, 1972 had five esophageal deformities.   An irregular postcricoid impression near the anterior wall at the pharyngoesophageal junction measured 8 mm in length and 6 mm in depth (Fig. 6A).   It changed in shape during deglutition (Fig. 6B).   A prominent smooth
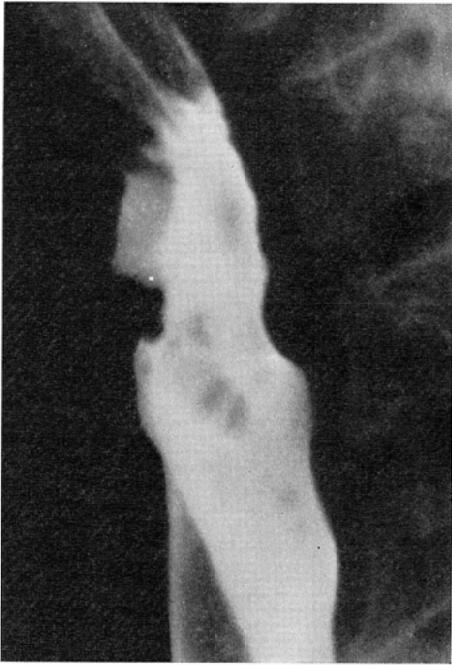

Fig. 6.   CASE V.   (A) A postcricoid impression in the lateral projection.   Note its irregularity and prominence.
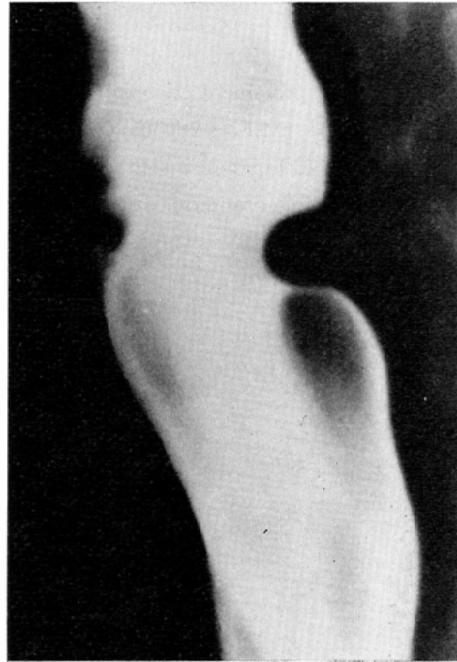
Fig. 6.   CASE V.   (B) Cricopharyngeal hypertro phy was also present.   Note the change in sh- ape of the anterior indentation.

posterior indentation below it was typical of cricopharyngeal hypertrophy.   There was also a Schatzki's ring in the lower esophageal region, an impression by an anomalous subclavian artery and impressions by vertebral osteophytes.   No swallowing disturbance or anemia had been evident.

CASE VI   (M.F. ♯ 304992)   Cricopharyngeal Hypertrophy

A 65-year-old Japanese male received an upper GI series on December 4, 1972 for hypochlorhydria, but denied dysphagia.   In the lateral projection, a smooth posterior impression was noted in the region of the pharyngoesophageal junction (Fig. 7).   This disappeared after passage of the barium and
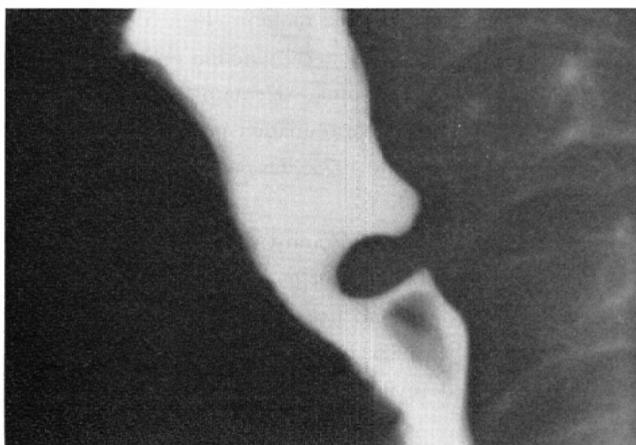
Fig. 7. CASE VI. Cricopharyngeal hypertrophy in the lateral projection.

was typical of a prominent cricopharyngeus muscle.

CASE VII (M.F. ♯ 260586) Vertebral Osteophytic Indentation

A 54-year-old Japanese male received an upper GI series on November 20, 1972 for hypochlorhydria. Markedly prominent anterior osteophytes at the level of C3-C4 compressed the esophagus on its posterior aspect (Fig. 8). This patient never complained of symptoms relative to deglutition.
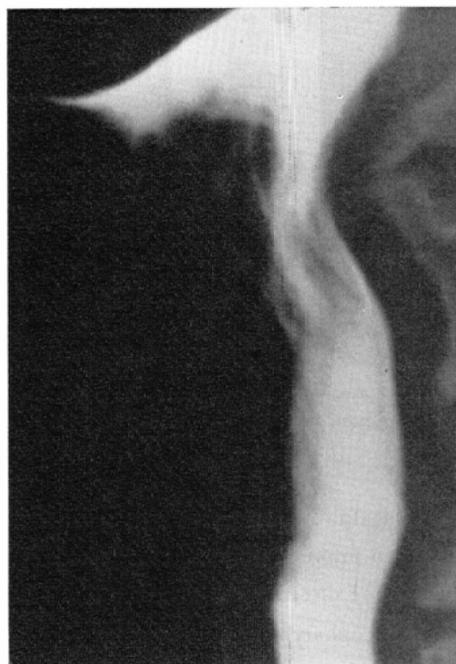

Fig. 8. CASE VII. A posterior indentation of the esophagus by a markedly prominent anterior cervical osteophyte. Lateral projection.

DISCUSSION

Esophageal Webs

Webs usually occur in the upper portion of the esophagus, as relatively thin (0.5–1.5 mm) indentations at right angles to the anterior wall immediately below the cricoid cartilage level. When small, they may be visible only in the lateral but not in the PA projection. Rarely, they may be in the thoracic portion of the esophagus. When of moderate or large size, in the PA projection, the web may appear as a transverse linear defect in the barium. Some webs are circular and are accompanied by marked dysphagia. Rarely, the constriction is not only membranous, but wide and cuff-like. The esophagus immediately below the web may not fill adequately due to interruption of the barium bolus.

In 1911 Clark[4] first described esophageal webs in the English language literature as "hymen." He regarded them of congenital origin. Kelly in 1919[15] found a circular membranous web which in Europe bore his name as part of the Paterson-Kelly syndrome—the counterpart of the American Plummer-Vinson syndrome. In 1935 webs were endoscopically confirmed by Hoover[13] whose punch-biopsy specimens showed they consisted of a thin layer of fibrous tissue between two layers of mucous membrane. Waldenstrom and Kjellberg's[33] detailed roentgenologic studies showed this to be the picture of sideropenic dysphagia—the Plummer-Vinson syndrome. Many such reports subsequently appeared. However, the Plummer-Vinson syndrome is not a definite clinical entity, and because of various definitions, its reported frequencies of webs vary widely.

Elwood et al. (1964)[7] radiologically identified 16 females with esophageal webs among 21 males and 104 females with dysphagia. He considered this frequency of webs in dysphagics comparatively low. Waldenstrom and Kjellberg[33] reported 3 webs inconsistent with the Plummer-Vinson syndrome. Asymptomatic cases without sideropenia or anemia were subsequently reported by Miller and Lewis in 1963[19] and Blendis et al. in 1965.[2] In 1967 Seaman[29] found 53 webs, 16 associated with anemia; 21, with dysphagia. Only 5 had both anemia and dysphagia.

Webs have rarely been reported in Japan. Our observations suggest that careful examination of the pharyngoesophageal junction should reveal more of them.

We have observed a total of 8 webs in our department, all of which were immediately below the cricoid cartilage level. Two were reported earlier[17], but reexamined during this one-year study of 90 subjects. Both were of the circular variety and were characterized by the barium jet phenomenon. These patients had concurrent anemia and dysphagia. Six newly detected webs consisted of anterior indentations in the barium column in the lateral projection, and these patients were asymptomatic. We observed no wide cuff-like webs. As for anemia, the average hemoglobin level at the last examination was 12.3 g/dl, slightly lower than the 13.1 g/dl, for all 90 subjects. Five of our 8 web cases had histories of anemia; 2 had hypochlorhydria or achlorhydria. The coexistence of webs and achlorhydria has already been reported[14].

Some investigators regard esophageal webs as congenital[4)34] but Mosher[20)22)28] felt they were due to scar tissue, subsequent to mucosal abrasion from trauma or infection. Hoover[13] noted atrophy in webs. Smiley et al.[31] further developed this concept and originated the following hypothetical trend: Fe-deficiency→foregut atrophy→web. In Japan, Furuuchi et al.[11] postulated that webs were caused by: anemia→atrophy→increased damage→ulcer→fissure and cicatricial constriction.

It is perhaps more appropriate to consider esophageal webs as a radiologic manifestation of atrophy of the esophageal mucous membrane—distinct from the concept of the Plummer-Vinson syndrome. A recent article[5] reports cases of webs which consisted of transverse folds of essentially normal mucosa and submucosa, and suggests that two types of webs may occur in the pharyngeal esophagus. The first type is related to epithelial changes as seen in the primary mucosal diseases; the second type representing simple plication of normal mucosa.

Blendis et al.[2] routinely fluoroscoped the cervical esophagi of patients with thyroid disease and found webs in 3 with goiters who never had anemia or iron deficiencies. Since the thyroid, mouth, esophagus and gastric mucosa all develop from the same endoderm, and the thyroid and web probably degenerate simultaneously, they considered webs the result of atrophy and degeneration of the upper portion of the esophagus. This was supported by Chisholm et al.'s[3] 1971 follow-up of 72 web cases, 11 of whom had thyroid disease, notably myxedema. Wright[36] described a female web case with a high thyroglobulin antibody titre. One of our web patients had a diffuse nontoxic goiter. The coexistence of colitis and webs has also been reported[35][36]. Some investigators have suggested that webs are related to autoimmune disease[10][11].

Mosher[23] and Kobayashi[16] stated that cervical vertebral osteophytes were relatively frequently associated with webs. We found indentations by osteophytes in 67% of the 90 subjects, only one of whom had both a web and vertebral osteophyte impression. Therefore, our findings cannot support their being correlated.

An increased frequency of esophageal cancer has been reported in follow-up studies of webs. Cancer of the lower pharynx or esophagus occurred in 5 of 72 patients followed by Chisholm et al. and reported in 1971[3]. In a study of 266 cases of postcricoid cancer in 1971, Richards et al.[26] found that there were earlier strictures of the hypopharynx in 23. Esophageal webs therefore deserve careful follow-up observations.

Some results of the present study were similar to those of Clements et al.[5] There were 6 new webs among 90 examinees in our series; 8, among their 100 patients. There was no dysphagia among our 6 subjects, nor in 6 of their 8 cases. They pointed out that there may be a different histopathological basis for two kinds of webs—the Plummer-Vinson type, and simple plication. Two of our cases and 2 of theirs were clinically of the Plummer-Vinson type. Their rates and ours for cricopharyngeal and postcricoid impressions were similar. We found a suggestive association between the existence of osteophytes and the development of cricopharyngeal hypertrophy.

Nosher et al.[24] reported the incidence of cervical esophageal webs as 5.5%, similar to our results. Our patients were females, while their 55 webs had no sex predominance.

Postcricoid Impressions

This entity has rarely been reported. Its radiologic features in the lateral projection consist of irregular indentations of varying thickness near the anterior esophageal wall immediately behind and below the cricoid cartilage, changing in shape during deglutition. Pitman and Fraser[25] found this in 104 of 121 dysphagics and in 64 of 71 asymptomatic individuals. They concluded them to be normal variants, unrelated to dysphagia. Postmortem studies showed that they were caused by the venous plexus immediately behind the cricoid cartilage.

Waldenstrom and Kjellberg[33] also stated that narrow incisions may occasionally be seen in the same area or immediately below it, and that they should be distinguished from esophageal webs. Seaman in 1967[29] and Chisholm et al. in 1971[3] noted similar indentations which they distinguished from webs.

Postcricoid impressions were detected in 69% of our cases, slightly lower than in Pitman and Fraser's report, but in agreement with Seaman's results[29]. Though there is no discussion of frequency by sex in the literature, our study indicated no predominance by sex. In our series webs occurred predominantly in females. Webs and postcricoid impressions appeared therefore to differ qualitatively. No abnormality in hemoglobin concentration was found in our postcricoid impression cases.

The clinical significance of postcricoid impressions lies in distinguishing them from webs and from postcricoid cancer[9]. Most webs are only about 0.5 to 1.5 mm in thickness and change little in shape during deglutition. Sometimes differentiation of postcricoid impressions from webs is impossible. This is particularly true when a web is immediately below the postcricoid impression. Whether it is a continuation of the postcricoid impression or an associated web cannot be determined, even by cinefluorography. We encountered several such cases.

Some reported series of webs apparently include postcricoid impressions. A correct understanding of postcricoid impressions is essential. Elwood and Pitman in 1966[8], studying the web detection rate in reviews of the same radiologic examinations performed by eitht radiologists, reported an observer variation of 6% to 59%. In only 3% of the cases was there complete agreement among the eight radiologists. This suggests possible confusion of webs and postcricoid impressions. Also of clinical importance is the differentiation between postcricoid venous impressions and postcricoid cancer. This is facilitated by observing the changes in shape of the postcricoid impressions during deglutition. However, diagnosis of postcricoid impressions without cinefluorography is difficult. They may be mistaken for early cancer when evaluated only by spot films.

Cricopharyngeal Hypertrophy

Cricopharyngeal hypertrophy, also referred to as an esophageal lip or hypopharyngeal bar, or spasm or hypertrophy of the cricopharyngeus muscle, is a characteristic posterior indentation at the pharyngoesophageal junction. Radiologically, in the lateral projection it is a marked, comparatively smooth indentation of the posterior wall as barium enters the esophagus. Templeton and Kredel[32] first considered such indentations as due to the cricopharyngeus muscle. We found this in 10 of our 90 subjects. Seaman in 1966[28] reported cricopharyngeal indentations in 5% of his cases. Most investigators consider it abnormal, and reliable evidence of neuromuscular dysfunction during deglutition. However, senile patients have sometimes been reported to have this without apparent cause[6]. Our cases ranged in age from 49 to 75 years, and the average of 65 years was somewhat older than that of the 90 subjects in this study. Cricopharyngeal hypertrophy may or may not be associated with dysphagia. Seaman in 1969[30] termed it "cricopharyngeal achalasia" when associated with marked dysphagia and reflux of pharyngeal contents into the larynx and trachea. Two of our patients with cricopharyngeal hypertrophy had dysphagia.

Compression by Anterior Cervical Osteophytes

Anterior cervical osteophytes also frequently cause cervical esophageal compression. Since Mosher's first case report in 1926[21], according to Maran and Jacobson[18], a total of 45 dysphagics due to

osteophytes have been reported, of whom only 9 were surgically proven and relieved of symptoms. This condition was encountered in 14 of 27 dysphagics, by Goto[12]. By including cases having the smallest osteophytes, 67% of our subjects had vertebral osteophytic indentations. Osteophytes occur frequently. As a cause of dysphagia, they must be carefully evaluated. Other etiologies must be ruled out as the cause of dysphagia, even when prominent exostoses of the cervical vertebrae are present.

Additional causes of dysphagia include disturbances of extensibility, or rigidity of the pharynx and esophagus due to edema and adhesions in the soft tissues anterior to the vertebrae, and abnormal stimulation of sympathetic nerves. Scatliff and Scibetta[27] in 1963 felt that dysphagia in osteophytic compression was secondary to neuromuscular dysphagia. We encountered 7 cases of cricopharyngeal hypertrophy among cases with osteophytic compression of the esophagus, suggesting correlation between the two entities. With barium swallow, the esophagus was indented posteriorly, clearly above the osteophytic indentation. The cricopharyngeal hypertrophy was not at the level of the osteophyte, but above it, just in front of the vertebral body itself. Osteophytes, of course, occur at more than one vertebral level, but the observation that the cricopharyngeal hypertrophy occurred above the level of the osteophyte suggests that longstanding osteophytic compression may cause compensatory hypertrophy of the cricopharyngeus muscle. We feel that this may be the reason for the greater frequency of cricopharyngeal hypertrophy among asymptomatic senile patients.

Our experience with these esophageal indentations indicated that some of them are not as rare as sometimes considered. Though some of the postcricoid impressions are not of great clinical impact in asymptomatic patients, they are very important in the differential diagnosis of postcricoid cancer. Moreover, postcricoid impressions must be more readily identified because of their similarity to cancer when visible only on spot films.

CONCLUSIONS

This study demonstrated that upper esophageal webs are not as rare in Japan as previously regarded. Postcricoid impressions, though not previously reported in the Japanese literature, were found in 69% of 90 subjects. Concerning upper esophageal webs and postcricoid impressions, 7 of the 8 web patients were females and all web cases had average hemoglobin levels lower than those of postcricoid impressions. The latter did not differ from those of the other 90 subjects—suggesting a different etiologic basis for these two entities. Cricopharyngeal hypertrophy was present in 11% of the subjects. The esophagus was compressed by osteophytes in 67% of the cases. There were 7 cases of cricopharyngeal hypertrophy in whom compression by cervical osteophytes may have induced compensatory hypertrophy of this muscle.

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