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DENTURE STOMATITIS
I. THE ETIOLOGY IN RELATION TO TRAUMA AND INFECTION

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INTRODUCTION

Denture stomatitis is a term describing the inflamed mucous membrane sometimes seen in the palate under a maxillary denture. Denture stomatitis may appear as a simple inflammation — localized to a limited area or involving the whole area covered by the denture — and as a granular inflammation, the latter most often localized to the central part of the hard palate. Denture stomatitis may be associated with angular cheilitis and itching or burning pain from the oral mucous membranes.

Cahn (1936) used the term 'denture sore mouth' (DSM) to describe the diffuse inflamed mucosa seen under maxillary full dentures usually accompanied by pain. *Nyquist* (1952) and *Newton* (1962) rather inconsistently included in the term DSM both localized and diffuse inflammation whether pain was present or not. In this paper the term denture stomatitis shall be used. It includes:

1) simple localized inflammation
2) simple diffuse (generalized) inflammation
3) granular inflammation (papillary hyperplasia)

Etiology of denture stomatitis

Trauma. Literature seems to give ample evidence of the correlation between trauma of the mucous membrane and denture stomatitis. *Hecht* (1939),

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Landa (1945), *Nyquist* (1952), *Kim* (1962), *Love* (1967), and *McKendrick* (1968) all found that an unbalanced occlusion and a poor fit of the dentures disposed to denture stomatitis. *Landa* (1945) and *Nyquist* (1952) reported a fairly good therapeutic effect after ajusting the dentures. *Newton* (1962) suggested that blockage of the duct openings of the mucous glands by the denture would cause a spread of saliva into the soft tissues of the palate that would give rise to an inflammation. This theory does not account for the diffuse erythema but may account for an inflammation of the mucous membrane confined to the posterior part of the hard palate where mucous glands are present.

Allergy. It has often been alleged that allergy to denture base materials, especially acrylic resin, may be the cause of denture stomatitis (*Rattner 1936, Cole* 1938, *Vickers* 1949, *Oehling* 1958 and more recently *Crissey* 1965). *Spreng* (1945, 1963) stated that there was sufficient evidence for an allergic denture stomatitis, when discontinuing to wear the denture led to a cure, reexposure to the denture led to a relapse of the stomatitis, and patch-testing with the denture base material gave a positive reaction. *Fisher* (1954) produced more scientific evidence that allergy to acrylic resin is an improbable cause of denture stomatitis. Among 20 patients with denture stomatitis he did not find any who were sensitized to heat-cured acrylic resin. Further more, he showed that a positive patch test to the patients dentures was a non-specific pressure reaction, as it could be reproduced by other materials.

Infection. Cahn (1936) and *Callar* (1945) suggested that Candida albicans might be responsible for denture stomatitis. *Lyon* and *Chick* (1957), *Cawson* (1963) and *Turrell* (1966) isolated Candida albicans more often from the palate of patients with denture stomatitis than from a control group. *Cawson* (1965) isolated hyphae in direct smears from the oral mucosa in 90 per cent of 50 cases of denture stomatitis. He also reported on a frequent association of angular cheilitis with denture stomatitis. Furthermore *Lyon* and *Chick* (1957) have reported on the beneficial effect of antifungal therapy in the treatment of denture stomatitis. Striking evidence of the significance of Candida albicans in the etiology of denture stomatitis was produced by *Lehner* (1965), who, using the quantitative immunofluorescent technique, has demonstrated statistically significant differences in antibody titer against Candida albicans in true controls, carriers and patients with denture stomatitis.

Denture cleanliness. It has been proposed, among others, by *Fisher* (1952) that poor denture cleanliness might dispose to denture stomatitis. *Love* (1967) and *McKendrick* (1968) found certain trends toward a poorer denture cleanliness associated with denture stomatitis. On the other hand, *Nyquist* (1953) could not produce any evidence of such a correlation. So far no in-

vestigators have given any criteria for a quantitative assessment of denture cleanliness.

It seems realistic to exclude allergy to denture base materials as a significant etiological factor, although an allergic reaction may be seen in rare instances. Both trauma and candida infection are proven etiological factors of denture stomatitis. Yet there remains the question whether some of these inflammatory conditions are due to a primary infection by candida or whether the yeasts are secondary invaders of traumatic lesions.

The primary aim of this investigation is to determine the relative significance of trauma and infection with Candida albicans in the etiology of denture stomatitis.

Secondly, it is the intention to see if denture stomatitis somehow could be related to denture cleanliness and the patients hygienic care of the dentures.

MATERIAL AND METHODS

The present investigation included 58 patients with full dentures and denture stomatitis; the control group consisted of 58 cases with full dentures and clinically normal mucosa of the palate. The distributions according to sex and age are recorded in Table I.

From all the patients a medical and dental history was recorded with special reference to factors which might dispose to denture stomatitis (traumatic or infective): antibiotic therapy, systemic diseases (endocrine deficiencies, iron-dificiency anaemia), edentulous age, age and numbers of dentures, denture usage and denture brushing frequence. Twenty two of the patients with denture stomatitis complained of burning and itching sensations of varying degree, especially provoked by intake of hot and spicy food. The symptoms were partially relieved when the patients discontinued to wear the

Table I.
Patient distribution according to sex and age

		25—34	35—44	45—54	55—64	65—74	75—84	Total	Mean age
Denture	Women	3	3	9	16	7	2	40	57.3
stomatitis	Men	—	—	6	5	6	1	18	58.9
group	Total	3	3	15	21	13	3	58	57.7
Conrol	Women	2	1	9	16	11	1	40	59.0
group	Men	-	2	3	7	5	1	18	59.6
	Total	2	3	12	23	16	2	58	59.2

dentures. All cases were submitted to a thorough extra and intraoral clinical examination. If a systemic disease was suspected the patient's physician was consulted.

The topography of the inflammatory processes was plotted on drawings of palate and tongue. A qualitative differentiation of the inflammatory intensity was made, distinguishing between slightly inflamed, moderately inflamed and severely inflamed mucosa. The following clinical inflammatory index was used:

slightly inflamed: slight erythema, scraping with a spatula does not produce any reaction of pain.

moderately inflamed: distinct erythema, scraping with a spatula produces a reaction of pain.

severely inflamed: the mucosa is fiery red, scraping with a spatula produces a reaction of pain and bleeding of the mucosa involved.

The quality of the alveolar processes as to retention and stability of the dentures (anatomic relations) was graded as,

satisfactory: well developed alveolar processes covered by a non-compressible mucosa.

moderately unsatisfactory: moderately developed alveolar processes and/or moderately compressible alveolar mucosa.

totally unsatisfactory: completely atrophied alveolar processes and/or extremely mobile alveolar mucosa.

The dentures were submitted to a functional analysis and accordingly the patients could be divided into two groups: those with traumatic dentures (unbalanced occlusion), and those with presumably non-traumatic dentures, the latter group consisting of either patients with balanced occlusion of the dentures and a free-way space of more than 2 mm or patients, fully edentulous, that only wore a maxillary full denture.

An examination of the denture cleanliness was made using a plaque detector to disclose the plaque on the fitting surface of the maxillary denture (Proflavine-monosulfate in 3 $^{0}/_{00}$ aqueous solution). According to the quantity of plaque on the denture base the patients could be divided into three groups using the following index of denture cleanliness:

excellent: none or only few spots of plaque.

fair: more extended plaque, less than half of the denture base covered by plaque.

poor: more than half of the denture base covered by plaque.

Isolation and identification of yeasts. On all of the patients, including controls, the palate was examined for yeast-like fungi. This was done by a method, adopted from *Bahn* (1962). An impression of the upper jaw was taken

in alginate (Coe-product). The impression was boxed with wax and poured in agar (2/3 Sabouraud's dextrose agar added 1/3 New Zealand agar) with penicillin added to suppress bacterial growth. After one hour the agar model was squeezed out of the impression and it was incubated at 37°C for 72 hours.

This method made possible the following:

First, to identify the yeasts. Colonies were examined for Candida albicans by tube formation in human serum. Yeasts different from Candida albicans were identified by fermentation tests.

Secondly, to determine the relative distribution of yeasts on clinically affected and clinically normal areas of mucosa.

Thirdly, to quantitate the yeasts by counting the colonies. The following quantitation was used:
none or few (0—10 colonies)
moderate (10—25 colonies)
profuse (> 25 colonies)

Scrapings. With a metal spatula scrapings were taken from the tongue and the palate of all the cases with denture stomatitis as well as controls. Scrapings from the angles of the mouth were taken in cases of angular cheilitis. The material was spread on slides, fixed in ether/alkohol 1:1 and stained according to the P.A.S.-method with hematoxylin as counterstain. The slides were evaluated with reference to occurrence of hyphal structures differentiating quantitatively between no hyphae, single hyphae and colonies of hyphae (mycelium).

Statistical methods

The chi-square test was used for testing the agreement between the values observed and the values expected.

$$X^2 = \sum \frac{(E-0)^2}{E}$$

Values of $P \leq 0{,}05$ were accepted as statistically significant.

RESULTS

The possible factors predisposing to denture stomatitis

A number of factors that might be related to the occurence of denture stomatitis were studied; namely, systemic diseases, the years of experience with dentures, denture age, number of dentures, denture usage, occlusion, quality of denture-bearing tissues, denture-brushing frequency and denture cleanliness.

In the denture stomatitis group 2 patients had gastric ulcers and one had gastric cancer. In one patient Sjögren's syndrome was diagnosed. The patient with Sjögren's syndrome had an intense generalized inflammation of the oral mucous membranes. Four patients in the present series were known to have received antibiotics which immediately led to the oral changes. The inflammatory signs had persisted even after the antibiotics had been withdrawn, and when this study was performed all 4 had generalized inflammation of the maxillary denture-bearing tissues.

The control group and the denture stomatitis group did not differ in age and sex distribution (Table I). The mean of the denture age as well as the mean of the years of experience with dentures were higher in the denture stomatitis group than in the control group (Table II). These differences were not statistically significant. The two groups did not differ in the mean number of dentures, in denture usage or in denture brushing frequence (Tables II, III, IV). In the control group all patients were wearing a full upper and a full lower denture. In the denture stomatitis group 11 patients wore only a full upper denture although they were fully edentulous.

The occlusal relations tended to be better in the control group than in the denture stomatitis group (Table V). In the control group 28 patients had presumably non-traumatic dentures as compared with 18 patients in the denture stomatitis group. This difference was not statisticlly significant. The study of the quality of the denture-bearing tissues revealed a statistically significant difference ($0{,}01<P<0{,}05$) between the denture stomatitis group and the control group (Table VI). In the control group 34 patients had well-developed alveolar processes covered by a non-mobile alveolar mucosa as compared with 19 patients in the denture stomatitis group.

Table II

Means, x for years of experience with dentures, age of dentures, number of dentures, and age of patients

		Years of experience with dentures	Number of dentures	Denture age	Age of patients	Total
Denture stomatitis group	Women	26,5	2,4	10,0	57,3	40
	Men	27,4	3,0	9,0	58,9	18
	Total	26,8	2,6	9,7	57,7	58
Control group	Women	21,8	2,6	4,2	59,0	40
	Men	18,3	3,2	4,0	59,6	18
	Total	20,7	2,8	4,1	59,2	58

Table III

Comparison of the denture usage of the denture stomatitis group and the control group

	Upper and lower dentures Day and night	Day	Upper denture Day and night
Denture stomatitis group	35	12	11
Control group	41	17	—

Table IV

Comparison of the denture -brushing frequence of the denture stomatitis group and the control group

Frequence	1	2	>2	Total
Denture stomatitis group	10	27	21	58
Control group	7	32	19	58

Table V

Distribution of cases with traumatic or non-trautamatic dentures

Denture function	Traumatic	Non-traumatic	Total
Denture stomatitis group	40	18	58
Control group	30	28	58

$X^2 = 2.9$ 1 DF $0.05 < P < 0.1$

Table VI

Distribution according to the quality of the denture-bearing tissues as to retention and and stability of the dentures.

Quality of denture-bearing tissues	Satis-factory	Moderately unsatisfactory	Totally unsatisfactory	Total
Denture stomatitis group	19	12	27	58
Control group	34	4	20	58

$X^2 = 8.6$ 2 DF $0.01 < P < 0.05$

Table VII

Distribution according to denture cleanliness

Denture cleanliness	Excellent	Fair	Poor	Total
Denture stomatitis group	7	31	20	58
Control group	35	16	7	58

$X^2 = 27.2$ 2 DF $P < 0.001$

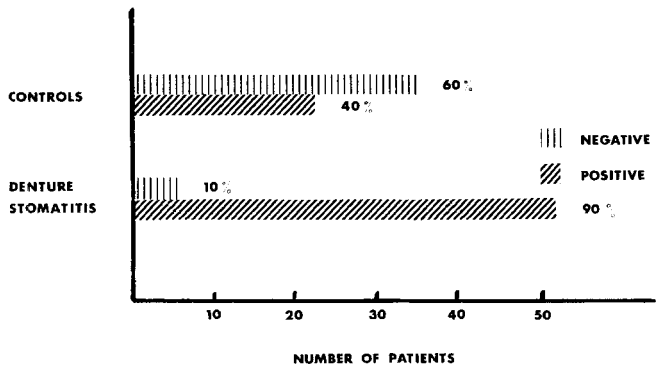


Fig. 1. Qualitative analysis of yeast-like fungi in denture stomatitis isolated by the impression method. Graphical recording showing number of patients with positive growth.

The denture cleanliness was far better in the control group than in the denture stomatitis group (Table VII). In the control group 35 patients had clean dentures as compared with 7 patients in the denture stomatitis group. This difference was statistically significant ($P<0{,}001$).

Qualitative and quantitative analysis of yeast-like fungi

The qualitative examination of the 58 controls revealed yeast -like fungi from the palate in 23 cases, or 40 %, with the impression technique compared to 52 cases, or 90 %, in the denture stomatitis group. These findings are recorded graphically in *Fig. 1.* The laboratory identification of the cultivated yeasts showed the following distribution:

	C. albicans	Other yeast-like fungi	Negative	Total
Denture stomatitis	48	4	6	58
Controls	16	7	35	58

Other yeast-like fungi comprised the following species: *Candida tropicalis*, *Candida guiltiermondii*, *Torulopsis glabrata* and *Saccharomyces cerevisiae*. In 9 cases with denture stomatitis other yeast-like fungi as well as *Candida albicans* were identified.

The quantitative analysis of yeast colonies in controls compared to the denture stomatitis group is recorded in Table VIII. Yeast colonies were found in greater numbers in cases with denture stomatitis than in the controls. This difference was statistically significant ($P<0{,}001$).

The quantitative examination of P.A.S.-stained smears from the control group showed 5 cases (9 %) with single hyphae in smears from the palate

Table VIII

Comparison of the quantity of yeast colonies of the denture stomatitis group and the control group. The relationship between the quantity of yeast colonies by cultivation and the inflammatory types.

Inflammatory types	Quantity of yeast colonies			Number of patients	
	0—10	10—25	>25		
Localized simple	10	2	1	13	$X^2 = 12.3$
Generalized simple	5	7	10	22	$0.001 < P < 0.01$
Granular	6	5	12	23	
Total denture stomatitis	21	14	23	58	$X^2 = 39.6$ 2 DF
Control group	53	4	1	58	$P < 0.001$

and 4 cases (7 %) with single hyphae in smears from the tongue, (*Fig. 2*). In no cases was mycelium found. In 18 cases blastospores were found in very small quantities in smears from the palate and the tongue.

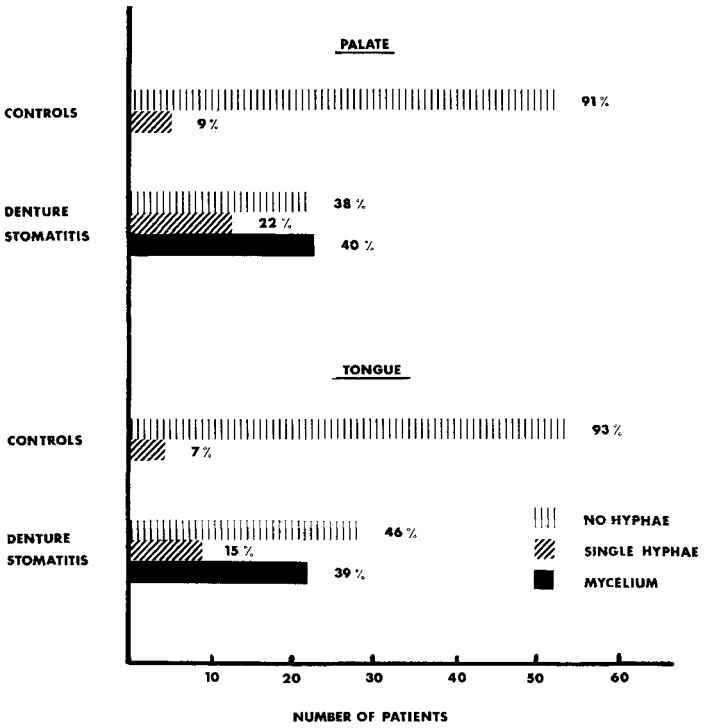


Fig. 2. Quantitative analysis of yeast-like fungi in denture stomatitis. Graphical recording showing number of patients with hyphae in smears from the palate and the tongue.

In the denture stomatitis group 23 cases (40 %) showed mycelium and 22 cases (38 %) single hyphae in smears from the palate (*Fig. 2*). Only 7 cases (12 %) showed heavy occurrence of hyphal structures in smears from the palate. In smears from the tongue mycelium was found in 22 cases (38 %), more readily and in greater quantities than from the palate; 9 cases (15 %) showed single hyphae in smears from the tongue. Blastospores were found inconsistently mostly in rather small numbers in smears from the tongue and the palate.

Localization of yeast colonies

The localization of the yeast colonies on the model of Sabouraud's agar was studied and correlated to the inflamed areas of the maxilla (*Fig.3*). In 30 out of 33 cases of both the localized simple inflammation and the granular inflammation, which were positive for yeasts, the colonies were localized to the inflamed areas (*Fig. 3, a^1 and c^1*):

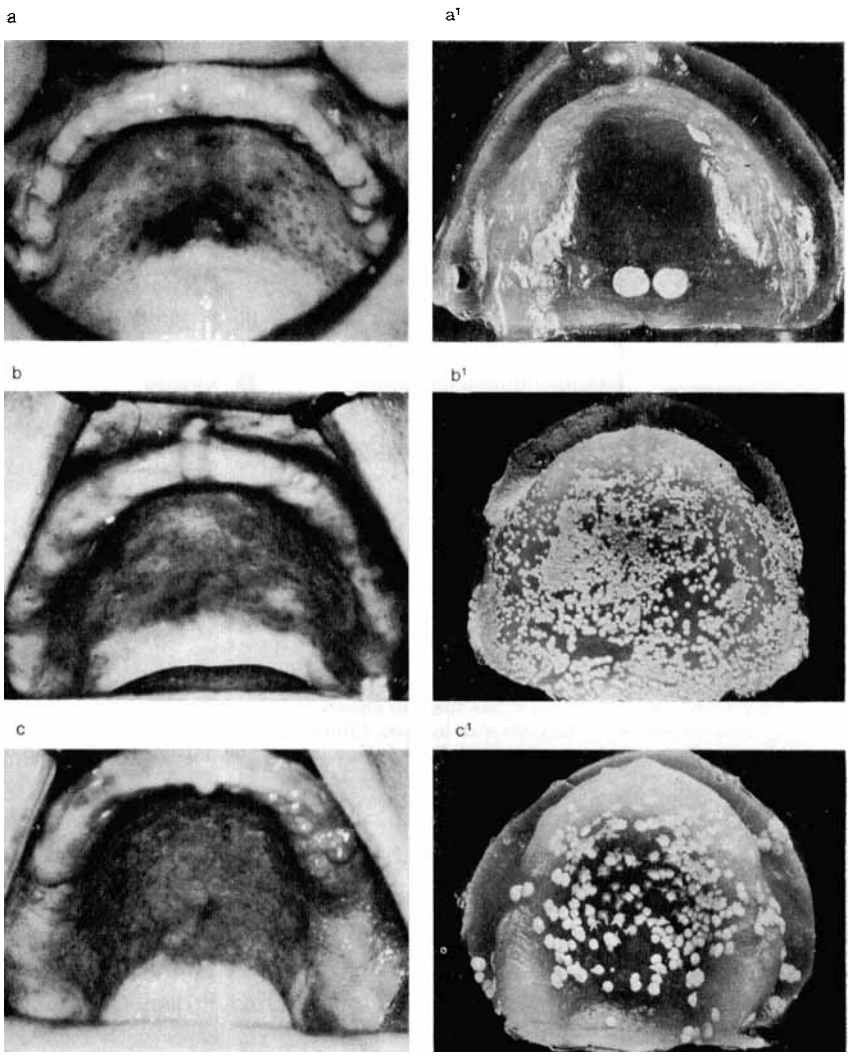
	Positive correlation	Negative correlation
Simple localized inflam.	8	3
Granular inflam.	22	0
Total	30	3

In cases of the generalized simple inflammation, with heavy occurrence of yeast colonies by cultivation, the yeast colonies could be seen covering the total denture-bearing area of the maxilla (*Fig. 3, b^1*).

Inflammatory types correlated to the quantity of yeast colonies and hyphae

Yeast colonies were cultivated in greater quantities from cases with a more generalized or granular inflammation than from cases with a localized simple inflammation (Table VIII). This difference was statistically significant ($0{,}001 < P < 0{,}01$). On the other hand, the group of cases with a localized simple inflammation did not differ significantly from the control group in quantity of yeast colonies.

The quantitative examination of P.A.S.-stained smears from the 13 cases with a localized simple inflammation showed single or no hyphae, in no case was mycelium revealed, neither from the palate nor from the tongue (*Fig. 4*). In the group of cases with a more generalized inflammation mycelium was isolated in smears from the palate in 10 out of 22 cases and from the tongue in 14 out of 22 cases (*Fig. 4*). Among the cases with a granular inflammation mycelium was found in smears from the palate in 13 out of 23 cases and in smears from the tongue in 8 out of 23 cases (*Fig. 4*).



As seen from the graphical recordings single hyphae were revealed in smears from the palate in a rather high percentage in the group of cases with the generalized simple inflammation (37 %) compared to the granular inflammation (17 %) and the localized simple inflammation (7 %).

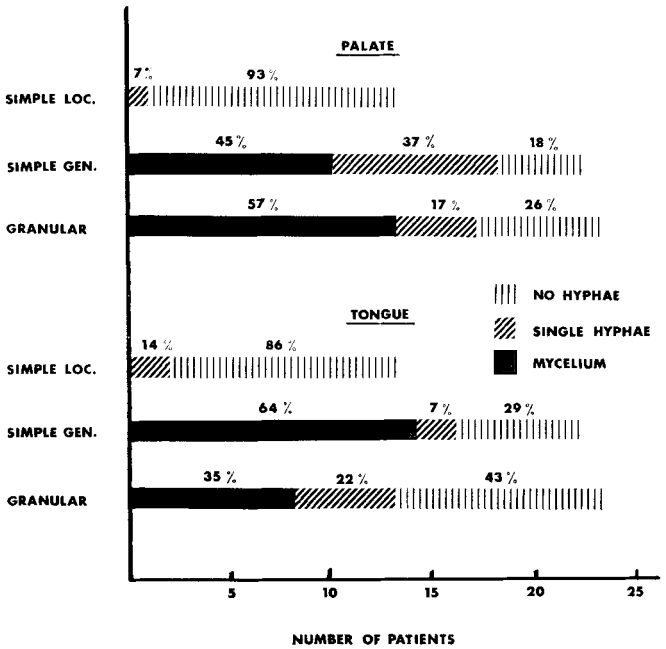


Fig. 4. Quantitative analysis of yeast-like fungi in smears from palate and tonque. Graphical recording showing number of patients with hyphae, differentiating between patients with simple localized inflammation, simple generalized inflammation and granular inflammation.

Inflammatory types correlated to the accompanying signs and symptoms

The accompanying signs and symptoms of denture stomatitis met with in this investigation were burning or itching pain of varying intensity from the oral mucosa, angular cheilitis and glossitis. These signs were found almost exclusively in the groups of cases with granular or generalized inflammation of the maxillary denture-bearing tissues, and not among the cases with localized inflammation. Pain was present in 1 of the cases with localized inflammation in 13 (59 %) of the cases with generalized inflammation, and in 8 (35 %) of the cases with granular inflammation (*Fig.* 5). Angular cheilitis and glossitis were absent among the cases with localized simple inflammation. Angular cheilitis and glossitis were present in respectively 9 (41 %) and 12 (54 %) of the cases with generalized inflammation and in 5 (22 %) and 10 (44 %) of the cases with granular inflammation (*Fig.* 5). Eighteen patients showed localized or generalized inflammation of the dorsal surface of the tongue with more or less marked atrophy of the filiform papillae. In 4 patients a median rhomboidean glossitis was present. Pain, angular cheilitis and glossitis were corre-

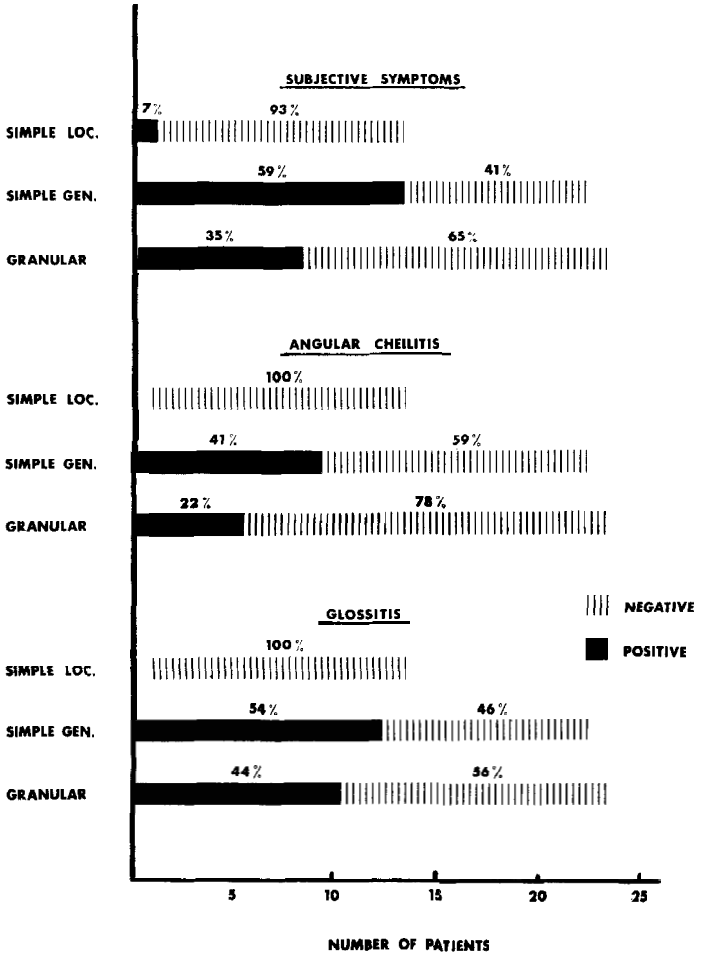


Fig. 5. Graphical recording showing number of patients with subjective symptoms, angular cheilitis and glossitis. Differentiation between the simple localized inflammation, the simple generalized inflammation and the granular inflammation.

lated to the presence of mycelium in smears from the tongue and the angles of the mouth. Mycelium was present in smears from the tongue in all of the 22 cases with glossitis. In 13 out of 14 cases (93 %) with angular cheilitis mycelium was present in smears from the angles of the mouth. Out of 22 cases with pain from the oral mucosa 15 cases had glossitis and/or angular cheilitis and in all 15 mycelium was found in smears from the tongue and/or the angles of the mouth. Four out of 7 (57 %) with pain as the only accom-

Table IX

The relationship between the denture cleanliness and the quantity of hyphae in smears from the palate

Denture cleanliness	Quantity of hyphae		
	No hyphae	Single hyphae	Mycelium
Excellent	5	0	2
Fair	13	7	11
Poor	5	5	10
	$X^2 = 2.6$	2 DF	$0.05<P<0.1$

panying sign to denture stomatitis did not reveal mycelium in smears neither from the tongue nor from the palate.

Correlation between the denture cleanliness, the inflammatory degree and the quantity of hyphae and yeast colonies

The difference in denture cleanliness between the denture stomatitis group and the control group was significant ($P<0{,}001$) (Table VII). Hyphae as well as yeast colonies were found in greater quantities in cases of poor denture cleanliness, but this connection was statistically significant only for yeast colonies (Tables IX and X). On the other hand, when the denture cleanliness was correlated to the inflammatory degree, a pronounced statistical significance was found between poor denture cleanliness and heavy inflammation ($0{,}001<P<0{,}01$) (Table XI).

Finally, the inflammatory degree was correlated to the quantity of hyphae and to the quantity of yeast colonies (Table XII and XIII). Both hyphae and yeast colonies were found in statistically significant greater quantities in cases of severe inflammation ($0{,}01<P<0{,}05$).

Table X

The relationship between the denture cleanliness and the quantity of yeast colonies by cultivation

Denture cleanliness	Quantity of yeast colonies		
	0—10	10—25	>25
Excellent	5	0	2
Fair	12	11	8
Poor	4	3	13
	$X^2 = 7.8$	2 DF	$0.01<P<0.05$

Table XI

The relationship between the denture cleanliness and the inflammatory degree

Denture cleanliness	Degree of inflammation		
	Slight	Moderate	Severe
Excellent	6	1	0
Fair	7	17	7
Poor	0	8	12
	$X^2 = 14.4$	2 DF	$0.001<P<0.01$

Table XII.

The relationship between the inflammatory degree and the quantity of hyphae in smears from the palate

Degree of inflammation	Quantity of hyphae		
	No hyphae	single hyphae	mycelium
Slight	10	0	3
Moderate	10	6	10
Severe	3	6	10
	$X^2 = 10.8$	4 DF	$0.01<P<0.05$

Table XIII.

The relationship between the inflammatory degree and the quantity of yeast colonies by cultivation

Degree of inflammation	Quantity of yeast colonies		
	0—10	10—25	>25
Slight	8	2	3
Moderate	11	8	7
Severe	2	4	13
	$X^2 = 11.1$	4 DF	$0.01<P<0.05$

DISCUSSION

The isolation of yeast-like fungi by the impression technique seems to be a more reliable method than the swab technique. *Turrell* (1966) has made a summary of findings of four investigations into the incidence of candida on inflamed upper denture-bearing tissues (*Lyon & Chick*, 1957; *Shuttleworth & Gibbs*, 1960; *Cawson*, 1963 and *Turrell*, 1966). Out of a total of 122 patient with denture stomatitis yeast-like fungi were isolated by firm swabbing in

96 (79 %) and in 15 (18 %) out of 83 controls. In this investigation the positive yield of yeast-like fungi was 90 % in the denture stomatitis group and 40 % in the control group, hence a more frequent carrier rate for candida was found by this technique than has been found by the swab technique.

The impression technique has been a useful method for demonstrating the close topographical correlation between inflamed denture-bearing tissues and the presence of yeast-like fungi. The fact that yeast colonies are found in statistically significant greater quantities when the inflammation is severe does demonstrate a close connection between yeast-like fungi and inflamed mucosa, but does not necessarily establish the infective origin of denture stomatitis. It is readily acknowleged that the quantitative analysis is not quite reliable as blastospores, single hyphae and mycelium might give rise to equal numbers of yeast colonies by cultivation.

The examination of a direct smear from the inflamed area is a more informative way to establish the patogenicity of candida. There is evidence from other candidal infections that pathogenicity is associated with the hyphal form (*Kozinn & Taschdjian* 1962, *Jepsen & Winther* 1965). *Cawson* (1965) isolated hyphae in 90 % of 59 cases of generalized inflamed mucosa of the palate. In this investigation 83 % of 22 cases of simple generalized inflammation revealed hyphae. That single hyphae and no actual mycelium were found in 37 % of the 22 cases may be explained by the fact that it was rather difficult to get sufficient material in scrapings from areas of simple inflammation. The glossal scrapings and the scrapings from cases of granular inflammation more readily yielded sufficient material – and mycelium. It is remarkable that a high yield of hyphae usually was found in smears from cases of severely inflamed mucosa.

Although the present investigation corresponds well with the findings of Cawson as to the etiology of the generalized simple inflammation of the denture-bearing tissues the term 'chronic atrophic candidosis' (*Lehner*, 1963) should not be used as a clinical diagnosis, as cases of generalized inflammation do exist from which yeast-like fungi cannot be isolated neither by cultivation nor in smears.

Hyphae were found in 74 % of 23 cases with granular inflammation, whereas 96 % revealed yeasts by cultivation. These findings are an indication of a close connection between yeast-like fungi and granular inflammation, but does not reveal anything about the course of events: is the hyperplasia the result of a long-standing candida infection or is the candida infection secondary to the hyperplasia, the crevices between the papilliferous outgrowths affording a nidus for candidal growth.

The patients in this investigation were selected and therefore do not re-

present a normal distribution as to inflammatory types. Probably the inflammatory type most often encountered is the localized simple inflammation and these cases can be more easily ascribed to local traumatic factors. In this investigation cases of localized simple inflammation were always associated with unbalanced occlusion, and hyphae which indicate the presence of candidiasis were found in only one case. Yet, the impression technique revealed a topographical correlation between the localized inflammation and the yeast colonies cultivated on Sabouraud's agar, a finding that adds proof to the theory, put forward, among others by *Henrici* (1930), *Lyon & Chick* (1957) and *Lehner* (1965) that a chronic traumatic injury to the oral mucous membrane predisposes to candidal growth and candida infection. It is probable that the close fit of a maxillary denture effectively cuts off the maxillary denture-bearing area from the free flow of saliva; hence candidal growth may increase and localized, traumatic lesions, infected by candida, could possibly progress into chronic atrophic candidiasis involving the total maxillary denture-bearing area. *Östlund* (1953) found that a close fit of the denture, accompanied by obstruction of the salivary ducts of the palate, led to a decrease in the mucous secretion. This decreased palatal salivation might well be a factor predisposing to candidal growth and candida infection.

The fact that 18 patients in this study had a more wide-spread simple or granular inflammation of the palatal mucosa, even though their dentures were persumably non-traumatic (11 patients did not wear their lower denture), does not exclude trauma as the primary etiologic factor. A more generalized candidiasis of the maxillary denture-bearing area, persisting even if trauma is not excerted on the mucosa, might well have been developed in the past from a localized traumatic lesion.

Systemic diseases may predispose to oral candidiasis. *Cawson* (1965) has reported on oral thrush in out-patients. *Sutphin* (1943), *Lehner* (1966) and *Sjöberg* (1966) reported on oral candidiasis in association with hypoparathyroidism. Much controversy exists whether diabetes is a predisposing illness to oral candidiasis (*Burman, 1966; Peters, 1966; Johnston*, 1967). Yeasts have been found in the oral cavity in great quantities in association with antibiotic therapy (*Smits* 1964, *Alteras* 1965). In this study antibiotic therapy might have been the predisposing cause of generalized inflammation of the maxillary denture-bearing tissues in 4 cases, systemic diseases possibly in 4 cases (but probably only in the case of Sjögren's syndrome). Yet the primary etiological factor may have been traumatic dentures and a chronic traumatic lesion of the maxillary denture-bearing tissues.

The fact that accompanying signs and symptoms as pain, angular cheilitis and glossitis were found rather frequently and almost exclusively among the

cases with the simple generalized and the granular inflammation is an indication of the frequent infective origin of these types of denture stomatitis and may be used as a diagnostic criteria (clinical) of candida infection of the maxillary denture-bearing tissues.

The correlation between poor denture cleanliness and severely inflamed mucosa of the palate was statistically significant. The poor denture cleanliness is probably primarily due to leucocytic emigration and to the continuous shedding of epithelial cells of inflamed mucosa and to a lesser degree by neglected hygienic care. Several of the patients with severely inflamed mucosa were in the habit of brushing their dentures very frequently — yet they had dirty dentures. Hyphae were usually found in rather limited quantities in smears and actual thrush was seen only in two cases. The plaque on the fitting surface of the dentures accordingly should not be taken for thrush.

SUMMARY

An attempt was made to determine the relative significance of trauma and infection with Candida albicans in the etiology of denture stomatitis.

In cultivating yeast-like fungi from a maxillary alginate impression yeasts were isolated in 52 out of 58 patients (90 %) with denture stomatitis, and in 23 out of 58 controls (40 %) with dentures, but without denture stomatitis. The impression technique seems superior to the swab method for isolation of yeast-like fungi in the palate. Furthermore, the impression technique gave striking evidence that the yeast-like fungi were located in the inflamed areas of the palatal mucosa, and a correlation could be established between the degree of inflammation and the quantity of yeast colonies found by cultivation.

The cases of generalized simple and granular inflammation were found to differ from the controls and the cases of localized simple inflammation in that:

1) yeast-like fungi were cultivated in significant greater quantities,
2) single hyphae and mycelium were found consistently in smears from the palate and the tongue,
3) subjective symptoms, angular cheilitis and glossitis were seen almost exclusively among the former.

The denture cleanliness was studied by means of disclosing solution and it was found that poor denture cleanliness primarily was associated with severe inflammation, whereas the correlation between poor denture cleanliness and the quantity of yeast-like fungi in smears and by cultivation was less pronounced.

The role of trauma as an etiological factor of denture stomatitis is not yet quite clear. In this investigation it was found that trauma alone may give rise to simple localized inflammation and in rare instances to a more generalized inflammation. Quite certainly traumatic lesions of the oral mucosa predispose to candida growth, yet candida growth and candida infection were seen under presumably non-traumatic dentures. It still remains a question as to which factors are responsible for the specific clinical picture of the granular inflammation, but probably both trauma and infection with Candida albicans are involved.

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RÉSUMÉ

STOMATITE PROTHÉTIQUE

I. VALEUR ÉTHIOLOGIQUE DES TRAUMATISMES ET DE L'INFECTION

Cette étude a été entreprise dans le but d'essayer de déterminer la signification relative des traumatismes et de l'infection à Candida albicans dans l'étiologie des stomatites sous plaques prothétiques. Par la culture des champignons levuriformes à partir d'une empreinte à l'alginate de la mâchoire supérieure, des levures ont été isolées chez 52 des 58 patients présentant une stomatite prothétique (90 %), et chez 23 des 58 patients du groupe témoin, qui étaient porteurs de prothèses mais ne présentaient pas de stomatite prothétique (40 %). L'emploi d'une empreinte semble être une technique supérieure au prélèvement par écouvillon quand il s'agit d'isoler les champignons levuriformes du palais. De plus, l'emploi d'une empreinte permettait de démontrer de façon frappante que les champignons levuriformes étaient localisés dans les zones enflammées de la muqueuse palatine, et il a été possible d'établir une corrélation entre le degré d'inflammation et la quantité de colonies de levures obtenues par culture.

Les cas d'inflammation généralisée simple et granuleuse différaient des cas témoins et des cas d'inflammation localisée simple par les caractères suivant :

1) les champignons levuriformes étaient cultivés en quantité significativement plus grande,
2) des myceliums et des filaments isolés ont été trouvés régulièrement dans les frottis du palais et de la langue,
3) les symptômes subjectifs, la cheilite angulaire commissurale et la glossite se voyaient presque exclusivement parmi les premiers.

La propreté des prothèses a été étudiée au moyen d'un détecteur colorant en solution, ce qui a permis de constater que le manque de propreté de la prothèse était essentiellement associé à une sérieuse inflammation, tandis que la corrélation entre le manque de propreté de la prothèse et la quantité de champignons levuriformes dans les frottis et dans les cultures était moins prononcée.

Le rôle des traumatismes en tant que facteur étiologique des stomatites sous plaques prothétiques n'a pas encore été entièrement élucidé. La présente étude a montré que le traumatisme peut à lui seul provoquer une inflammation simple et localisée, et dans de rares cas, une inflammation plus généralisée. Sans aucun doute, les lésions traumatiques de la muqueuse buccale prédisposent à la croissance des Candida, mais il a cependant été possible de constater aussi la croissance de Candida et la présence d'infection à Candida sous des prothèses présumées non- traumatisantes. Quels sont les facteur responsables de l'aspect clinique spécifique de l'inflammation granuleuse? Cette question reste toujours ouverte, mais il est probable que l'action traumatique et l'infection à Candida albicans sont toutes deux en cause.

ZUSAMMENFASSUNG

STOMATITIS PROTHETIKA

I. ETHIOLOGIE IN BEZIEHUNG ZUR TRAUMA UND INFEKTION

Es war versucht, die relative Bedeutung von Trauma und Infektion mit Candida Albicans als etiologischer Faktor der Stomatitis prothetika zu entscheiden.

Bei der Zucht der Pilze von maxillaren Alginat-Abdrücken wurden die Pilze in 52 von 58 (90 %) Patienten mit Stomatitis prothetika und in 23 von 58 Kontroll-Patienten (40%) mit totalen Prothesen, aber ohne Stomatitis prothetika, beobachtet. Die Abdruck-Technik erscheint besser als die Abstrich-Metodik für die Ausgeschiedung der Pilze des Gaumens.

Die Abdruck-Technik gab ausserdem einen bedeutenden Beweis, dass die Pilze zu den entzündeten Oberflächen des Gaumens lokalisiert sein können, und es wurde eine Korrelation zwischen der Intensität der Entzündung und der Quantität von Zucht-Pilzkolonien festgestellt.

Es erwies sich, dass sich die Fälle der generalisierten einfachen und granulären inflammatorischen Reaktion von den Kontrollfällen und den Fällen der lokalisierten einfachen inflammatorischen Reaktion unterschieden, und zwar in folgenden Hinblicken:

1) die Pilze waren in signifikant grösseren Quantitäten kultiviert,

2) einzelne Hyphen und Myzelium waren häufig in Abstrich-Präparaten des Gaumens oder der Zunge gefunden

3) und subjektive Symptomen, Rhagaden und Zungeninflammationen waren beinahe nur zwischen den Erstgenannten gesehen. Die Prothesenhygiene war mittels einer »disclosing Solution» untersucht und es erwies sich, das ein schlechter hygienischer Zustand der Prothesen zunächst mit einer schweren Entzündung assoziert werden konnte, wogegen die Korrelation zwischen einem schlechten hygienischen Zustand der Prothesen und der Quantität der Pilze auf den Abstrich-Präparaten und bei der Zucht weniger ausgesprochen war.

Die Rolle des Traumas als ethiologischer Faktor der Stomatitis prothetika ist noch nicht ganz klar. Es war in dieser Forschungsarbeit gefunden, dass das Trauma lediglich eine lokalizierte, inflammatorische Reaktion und in seltenen Fällen eine mehr generalisierte, inflammatorische Reaktion veruhrsachen konnte. Sicherlich waren traumatische Verletzungen des oralen Mukosas für die Zunahme von Pilzen prädisponiert, doch waren Candida-Zunahme und Candida-Infektion in Fällen vermutlich nicht-traumatisierenden Prothesen gesehen.

Es ist noch eine offene Frage, welche Faktoren für das spezifische, klinische Bild der granulären Entzündung verantwortlich sind, aber vermutlich sind sowohl Trauma als Candida-Infektion darin eingeschlossen.

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