

# THE JOURNAL

of the AMERICAN DENTAL ASSOCIATION

Vol. 17

JUNE, 1930

No. 6

## Original Communications

### RELATION OF DIET TO GENERAL HEALTH AND PARTICULARLY TO INFLAMMATION OF THE ORAL TISSUES AND DENTAL CARIES\*

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(In collaboration with the Chicago Dental Research Club)

IN a paper presented before the Chicago Dental Society in May, 1929,<sup>1</sup> we called attention to the fact that the majority of people are eating food that is deficient in vitamin C. Dental disorders were almost invariably found to occur in persons whose diet is deficient in vitamins and, conversely, a freedom from dental disorders seemed, as surely, to be enjoyed by persons that were eating food that contained an abundance of vitamins. The important factor appeared to be vitamin C. The calcium and phosphorus values of the blood were never

found to be markedly subnormal, an apparent parathyroid deficiency was never encountered and a *marked* vitamin D deficiency was the exception rather than the rule. Conclusions were reserved for a later date because sufficient time had not elapsed to warrant a dogmatic opinion.

These studies have been continued, and we are today prepared to give a statistical report on 191 cases and a record of improvement in 104 cases. The method used in compiling this report is similar to that previously employed.<sup>1</sup>

The members of the Chicago Dental Research Club have supplied most of the patients and the dental information and have usually induced the patients to supply a set of dental roentgenograms. I have interviewed the patients, examined their mouths, questioned them rather fully on their general state of health with special reference to gastro-intestinal disturb-

\*Read before the Section on Mouth Hygiene at the Midwinter Clinic of the Chicago Dental Society, Jan. 14, 1930.

\*From the Otho S. A. Sprague Memorial Institute and the Department of Pathology, University of Chicago.

1. Hanke, M. T.: Relation of Diet to Caries and Other Dental Disorders, J.A.D.A., 16: 2263-2271 (Dec.) 1929.

TABLE 1.—Relation of Dietary Deficiencies to Gingival Irritation, Pyorrhea and Dental Caries\*

Age Range	No Dental Disorders				Caries				Caries and Gingival Irritation				Gingival Irritation and (or) Pyorrhea. No Caries.			
	Group 1 Dietary Deficiency				Group 2 Dietary Deficiency				Group 3 Dietary Deficiency				Group 4 Dietary Deficiency			
	None	C & D	C	D	None	C & D	C	D	None	C & D	C	D	None	C & D	C	D
0-10	2	1			2	6			7	1					1	
11-20	4		2	1	10	21			7	10				3	2	
21-30	1			1	7	4			13	6				3	7	
31-40			1		3	6			8	3				5	3	
41-50	2					2			3	5				4	10	
51-up	2									2			1	4	5	
Totals	11	1	3	2	None	22	39	None	38	27	None	1	19	28	None	

\*The total number of cases studied was 191. Of these, 17 (8.9 per cent) were free from dental disorders. The diet of only one of the seventeen persons was markedly deficient in vitamins. The diets of the 174 persons that were afflicted with some kind of dental disorder were all deficient in vitamin C, and of these, 94 (54 per cent) were eating diets that were deficient only in vitamin C. None of these persons were eating diets that were deficient only in vitamin D.

ances, nervous tendencies and possible endocrine deficiencies, made a thorough study of their previous diet, examined the blood for calcium and phosphorus and usually for other constituents, determined blood pressure, weight and height and noted the quality of the muscular tissue, and frequently conducted a urine analysis, and have then made the necessary recommendations. The sum of this information makes it possible to draw fairly accurate conclusions as to the person's state of health, the dental condition and the vitamin intake.

The record on 191 cases has been completed to date. This includes, of course, only those cases in which we have been able to obtain information that is unquestionably reliable and adequate for our purposes. The results are summarized in Table I.

For the sake of convenience, the dental disorders have been divided into four groups: 1. No dental disorders now. 2. Caries. 3. Gingivitis or pyorrhea and caries. 4. No caries. Other conditions as in Group 3.

You will note that seventeen of the 191 persons were free from dental disorders and, of these, eleven were eating a diet that contained ample vitamins. One of these patients, a boy of 17, was eating food that is unquestionably deficient in vitamin C. He had not developed any dental diseases, but his general health was poor. The dietary deficiency was slight in the remainder of these cases.

The uncomplicated caries group (Group 2) comprises sixty-one cases. The diets were invariably deficient in vitamin C, and in thirty-nine of these cases, there was no other demonstrable dietary deficiency. It is possible, therefore, to have active caries in persons whose blood calcium and phosphorus are normal and

whose diet is, apparently, not deficient in vitamin D.

Caries, associated with gingivitis (Group 3), was encountered in sixty-five cases. The diets were invariably deficient in vitamin C, and in twenty-seven of these cases, there was no other demonstrable dietary deficiency. A deficiency in both vitamins C and D was prevalent in this group (thirty-eight cases).

Of the forty-eight persons represented in Group IV, thirty-four had pyorrhea. Caries was absent in all cases. One of these patients was obtaining an abundance of vitamins. The marked gum irritation, with which she had been afflicted for some time, proved to be due to occlusal trauma. With this one exception, the diets were invariably deficient in vitamin C, and in twenty-eight of these cases there was no other demonstrable deficiency.

This survey gives values that are almost identical with those previously obtained in a smaller group. The inevitable conclusion again is that a lack of vitamin C may be an important factor in the initiation of dental diseases.

That we may not be misunderstood, it may be well to state that we are not of the opinion that any syndrome is specifically due to the direct effect of a lack of any one vitamin. Many factors are involved in the proper functioning of any body cell, and all of the body hormones and all of the vitamins are, probably, equally important in maintaining a cellular condition that is efficient. We have been placing particular stress on vitamin C because it is just *the* factor in which the majority of diets are deficient. The food that we have been advocating contains, as far as we now know, all of the factors that are essential for health. This consists, usually, of milk, from 1 to 2 pints a day, meat, fresh vegetables,

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Fig. 1.—Gingival tissue of excellent quality. This patient has been ingesting the diet, previously described, for one year.

Fig. 2.—Gingival tissue of good quality in spite of the fact that the teeth are heavily covered with plaques. The plaques have been revealed, for photographic purposes, by means of Bismarck brown disclosing solution (formula and technic given at end of text).

Fig. 3.—Thick firm gingival tissue of good color. The thickening is not due to a subgingival calculus.

Fig. 4.—Soft gingival tissue, with almost no thickening, especially noticeable around the lower teeth. The color suggests a hyperemia and microscopic examination reveals the presence of numerous short, thick blood vessels. These are never seen in healthy gingival tissue.

Fig. 5.—Soft gingival tissue that is very thick and of poor color but does not bleed when brushed. The microscopic examination reveals a stage of congestion far greater than that represented by the condition in Figure 4.

Fig. 6.—A typical example of spongy gingival tissue.

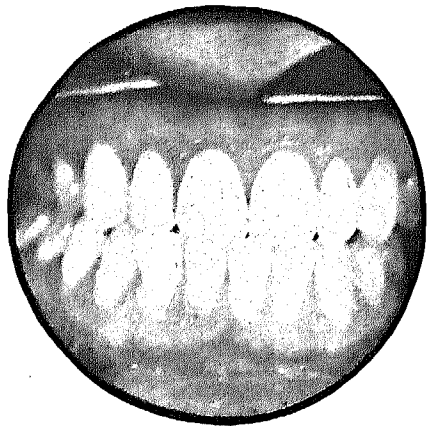


FIG. 1

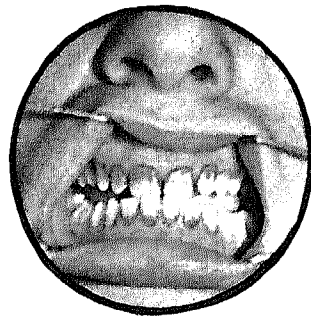


FIG. 2

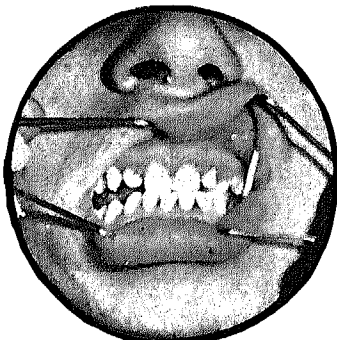


FIG. 3

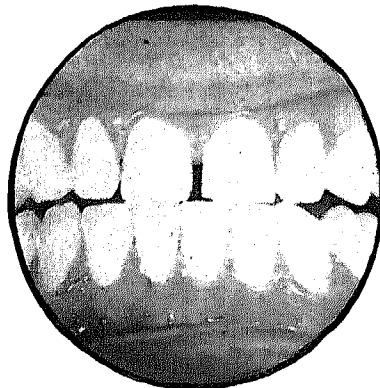


FIG. 4

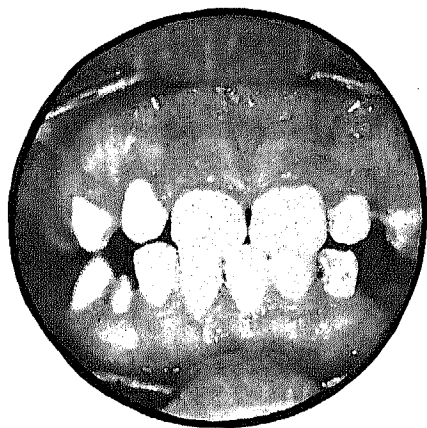


FIG. 5

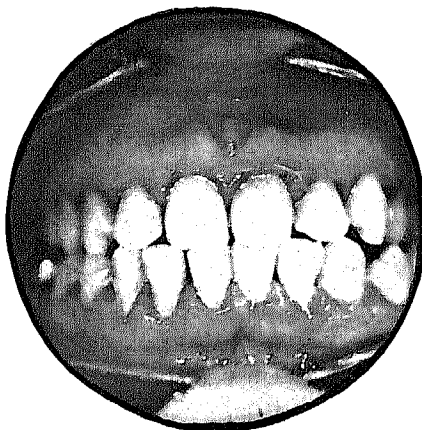


FIG. 6

from one-fourth to one-half a head of lettuce a day, the juice of one-half lemon and one-half pint of orange juice once or twice a day, this depending on the age of the individual and on the susceptibility to a vitamin C deficiency, one or two eggs a day and any desired amount of fresh fruit.

We have, perhaps, stressed the essential *quantity* of certain of these foods more than has, heretofore, been the case. This has been due, largely, to the fact that we watched these patients closely for results and have, quite empirically, increased the intake of certain factors until a quantity was being ingested that produced the desired results (usually a solidification of the gum tissue and a tendency for this tissue to adhere firmly to the supporting tissue). The most potent factor in this diet is, unquestionably, the orange and lemon juice; and it is effective only when it is given in much larger amounts than have heretofore been generally advocated. Our initial recommendation was that the juice of one lemon and two large oranges be taken every day. This is approximately half a pint of combined juice.

The results were very gratifying. Gingivitis decreased rapidly in most cases and disappeared completely in many cases. This quantity appears, also, to have been sufficient to check dental caries because none of the earlier patients have developed new cavities (period, one year). A number of patients that were improved did not show the marked improvement that had been observed in others; so we increased the dosage to the juice of one-half lemon and one-half pint of orange juice twice a day. This has appeared to be adequate in all cases, and this is the amount that we have recommended during the past eight months. We have recommended orange and lemon juice be-

cause it is, so far as we now know, the most concentrated source of vitamin C, and it seldom leads to physical disturbances. A diarrhea that may occur in some cases soon after the diet is instituted will almost invariably disappear in two to four days. An idiosyncrasy to citrus fruit is so rare that, of about 500 persons that I know of who are ingesting a pint of orange and lemon juice a day, not one has developed any allergic symptoms. Of the other important sources of vitamin C (tomatoes, cabbage and lettuce), we have advocated only the latter, and then not particularly because of its vitamin C content. Tomatoes are, unquestionably, a good and fairly inexpensive source of vitamin C; but the protective quantity is rather more than most persons would care to take consistently, and tomatoes frequently lead to gastro-intestinal disturbances. Most of our patients have, of course, been eating both tomatoes and cabbage as adjuncts to the food more specifically recommended.

A curious quantitative relationship should be mentioned in passing. The recent work of Eddy<sup>2</sup> has shown that 3 c.c. of orange juice per day is required by a 1-pound guinea-pig to insure freedom from changes in the pulps of the teeth. If we assume that man and the guinea pig are equally susceptible to a vitamin C deficiency, a 150-pound man would require 450 c.c. (1 pint) of orange juice a day. This is, indeed, the amount that we have empirically determined to be adequate.

Considerable has been written about vitamin C, and we shall probably have more to say about this substance. It should be remembered that we have not, and do not claim to have, proved that

2. Eddy, W. H.: An Improvement in the Quantitative Assay of the Antiscorvy Vitamin (C).

this vitamin is the potent factor in our diet. We believe that it is the potent factor because the changes that we have observed in the gingival tissues are exactly those that one would expect to obtain after the administration of vitamin C; but what we have really shown is that certain changes are produced by certain foods. The potent constituents of these foods may or may not be vitamin C, or, for that matter, any vitamin; but the effects are undeniable, and this is, after all, the most important consideration. Time will tell whether the theory that led to the feeding of these foods is or is not correct.

A diet such as has been described above has now been recommended to about 500 persons. Some of them have and others have not cooperated. In this group, an accurate series of re-checks over a sufficient period of time has been completed in 104 cases. Table 2, which summarizes these results, represents a great variety of conditions and a varying time of observation that are not easily tabulated. We have had patients with almost every conceivable type of gingivitis, with and without carious lesions, and cases of pyorrhea that varied from a shallow purulent infection to one in which there had been a profound involvement of the supporting bone. None of the patients have been under observation for less than four months, and many of them have been observed by the same dentist for from ten to twenty years. Gingival changes occur rapidly; but it would be quite irrational to draw conclusions about dental caries only when the patients have been carefully observed for at least eight months.

By arrested caries we mean that, to the best of their ability and frequently with the aid of roentgen rays, the dentists have been unable to find any evidence

of new carious areas, nor have they observed an increase in the size of the lesions that were present. We all realize that eight months is too short a period, under imperfectly controlled conditions, in which to draw radical conclusions about dental caries. We have under way, at the present time, an extensive program which will enable us to ascertain, under highly controlled conditions, whether or not the conclusions that we are tentatively drawing at the present time really represent the truth.

The outstanding result of the dietary treatment has been the improvement in general health. The patients have almost invariably observed an increased alertness and an increased ability to work or play without fatigue. A number of patients, both children and adults, that were quite obviously underweight have gained from 10 to 30 pounds during a three-month period. This has not been a constant finding. The weight of the frankly obese patients has not been influenced particularly. The resistance to infection appears also, in many cases, to have been materially increased. This was particularly noticeable in patients that had, previously, been constantly afflicted with head colds. In one case, a severe osteomyelitis of long standing has been completely cured. Our findings are, on the whole, in rather close harmony with those reported by Lovell Langstroth, who recommends a diet very similar to the one that we have been advocating.<sup>3</sup>

Of the 104 patients, fifteen did not cooperate at all. None of these cases showed any spontaneous improvement and a few of them became worse. Sixty patients who had previously been afflicted with an active, progressive decay have

3. Langstroth, Lovell: Relation of American Dietary to Degenerative Disease, *J.A.M.A.*, 93:1607, 1929.

TABLE 2.—Improvements Associated with Changes in Diet\*

Previous Vitamin Deficiency	Added to Diet				General Health After Treatment			Dental Condition After Treatment <sup>1</sup>		
	No addition	Vitamin C	Vitamin C & D	Vitamin D	Improved	Unchanged	Worse	Decay arrested	Gum condition or pyorrhea improved or cured	No improvement
	5					4	1			5
Vitamins C and D		3			3			1	3	
			36		34	2		20	29	
				1		1				1
Vitamin C	10					6	4			10
		49			43	6		29	39	1

\*The total number of persons studied was 104. Of these, fifteen did not cooperate at all. They were either not improved or became worse. Perfect cooperation was obtained from eighty-five patients. A marked improvement in general health was obtained except in those cases in which the general health had previously been excellent. Gingival irritation (Vincent's infection, gingivitis or the inflammation associated with pyorrhea) was invariably improved or cured. Sixty patients in whom caries had previously been active have remained free from caries for eight months.



not developed new carious lesions, nor have the existing, unfilled lesions increased in size during an eight-month period.

Healthy gum tissue should be firm and should be firmly attached to the supporting structures. A really good quality of gum tissue is the exception rather than the rule. We have attempted to record gum structure by taking colored photographs of the mouth. The accompanying illustrations are representative of the conditions that are most common. The gums may be firm and of good color, but thick. The thickening occasionally observed is a bulge due to a submerged calculus. This has been demonstrated by actually removing the subgingival calculus. Such a condition cannot, of course, be corrected by dietary methods. This thick but firm type of gum tissue has been reduced to normal in a number of cases in which a subgingival calculus was not demonstrable, purely by dietary management. The observations of Wolbach, presented before this society, afford an excellent explanation for the cause of the thickness of these gums as well as for the fact that the ingestion of citrus fruit reduces the gums to a normal state. The thickening may well be due to the presence of an abnormal amount of fibrous tissue.

The soft, sometimes hypertrophied, type of gum tissue is very common. The color may or may not be good. The tissue offers little resistance when it is gently pressed with a metallic instrument. This slight pressure is usually followed by a momentary depression in the gum tissue that reminds one of an edematous condition. This is then followed by a temporary excessive redness of the injured area. Such gums do not bleed easily. A microscopic examination of the gingival tissue in the living

subject reveals, under 30 diameters magnification, a surface that contains many short but thick blood vessels that are far larger than a normal capillary and that are easily visible. Healthy gingival tissue never has this appearance. Soft gums almost invariably become firm after from thirty to sixty days of dietary management. The previously noted surface vascularity disappears.

The spongy gum, though not so common as the soft variety, is, none-the-less, rather frequently encountered. This, as we see it, merely represents a state of deficiency greater than that represented by the soft gum. The entire gum tissue may be spongy or the condition may be such that the soft gum tissue is interspersed with spongy areas. Spongy gums bleed easily. They are soft, thick and water-logged, and have no resiliency. The color is usually dark red and may be tinged with blue. The frankly infected surfaces of spongy gingival tissue consist of a structureless mass of dead tissue. The smooth intact adjacent surfaces are markedly hyperemic.

The acute inflammatory reaction in spongy gums usually subsides after from fourteen to thirty days of dietary management. The spongy gums that bleed easily are thus converted into soft gums that do not bleed even though they are brushed rather vigorously. The soft gums eventually become firm as outlined above. Table 2 shows an improved gum condition in seventy-two cases. This change is so obvious and has been observed so frequently (far more frequently than is indicated by the table) that we feel justified in concluding that many types of gingival abnormality are due to a dietary deficiency and the condition can be corrected by means of a diet such as we recommend.

We fully recognize the fact, of course, that bleeding of the gums is frequently associated with a possible local irritant. This local irritant may be mechanical (malocclusion) or it may be calculus or it may be bacteria. Gingival irritation that is due to malocclusion can hardly be remedied except by correcting the occlusion. Gums can seldom be made to take kindly to calculus even though the diet is perfect; but we have seen cases in which even this did occur. The presence even of thick bacterial deposits along the gingival margins does not, necessarily, indicate that the gums must be of poor quality. It is really easier to get people to eat good food than it is to get them to brush the teeth properly.

A correction of the gingival condition has usually occurred in spite of the presence of bacteria. We have, in our laboratory, two young men who are very susceptible to a vitamin C deficiency. The one does not ever clean his teeth well. It is possible, in this case, to produce an excellent, firm, gingival tissue in two weeks by feeding an abundance of orange and lemon juice (in spite of the bacteria), or, conversely, these gums will become spongy and bleed easily if the citrous fruit is withheld for two weeks. The other young man, on one occasion, went for thirty days without cleaning his mouth at all. (The diet was excellent.) At the end of this time, the teeth were heavily coated with plaques and the gums were coated with a bacterial film; but the gingival tissue was firm and of excellent quality, and there was no irritation at the gingival margins.

We come now to the condition that is called pyorrhea. We are frequently asked if we can cure pyorrhea. The answer will depend largely on what you would call a cure and on what you call pyorrhea. This condition may vary from

a simple, shallow purulent infection to one in which there is a profound involvement of the bone with large deep pus pockets and teeth that are, literally, floating. Between these extremes one can have almost any condition. An attempt to treat a pyorrhic condition without prophylaxis has been made in only one case. This heroic experiment was carried out by one of our group and it was successful.

It would, under ordinary circumstances, be pure folly to attempt to free a deep pus pocket from infection without introducing drainage or irrigation. An attempt has almost invariably been made, in our cases, to remove the pus and the infected bone as far as possible. The rapidity with which complete healing will occur in the very severe cases depends largely on how carefully and completely the infected bone is removed. A combination of good surgery and good food has led to many complete cures within sixty days. A good brushing technic has also been used. Brushing the gums toward the teeth not only produces an additional circulatory stimulus (vitamin C being one circulatory stimulus), but it also helps to empty the pus pocket, i. e., it helps to create drainage. We cannot say, therefore, that we have treated pyorrhea by purely dietary means. The results obtained have been due to a combined mechanical and dietary effort.

Simple, shallow purulent infections yield rather easily. The deeper the infection and the larger the pocket, the harder it is to effect a freedom from pus; but this ideal has been realized in a number of very bad cases even though the surgery was not always ideal. I have seen patients in whom bone curettement had not been resorted to, with an initial eight to twelve deep purulent pockets, return periodically with fewer involved

teeth at each visit. Months are required to effect a complete cure unless drastic curettement is resorted to. It must also be remembered that a pocket full of pus always represents a possible rapid invader. Food alone cannot completely counteract the ravages of lack of sleep or of worry; and a number of patients that have shown marked signs of improvement have had relapses following family catastrophies. On the whole, most pyorrhea cases can be rendered pus-free by a combination of proper prophylactic treatment and dietary management.

We can say but little with regard to the much mooted question of bone regeneration. We have seen cases in which there has, unquestionably, been some bone regeneration; but we have seen others in which there has just as certainly been no bone regeneration. We do not have any case in which bone destruction has continued after combined mechanical and dietary management was instituted.

A solidification of the teeth has been noted frequently, though not invariably. A tooth that is not surrounded by any appreciable amount of supporting bone can hardly become solid; but cases in which sufficient supporting bone remains will become fairly or quite solid as soon as the pericementum and the gums have become healthy. A healthy gum tissue will attempt to adhere firmly to the supporting structures.

Several of our group have had patients in whom the gum recession and bone absorption had proceeded to such an extent that the bifurcation of the roots of the molars protruded above the visible gum line. The combined mechanical and dietary treatment soon removed the pus. The gums attached themselves firmly to the supporting tissue; and these teeth are now quite solid although a space is pres-

ent below the projecting root bifurcation and the gum tissue. In one case, with an initial purulent involvement of ten teeth, nine have become free from pus and are quite solid and the one remaining pus-surrounded tooth gives trouble periodically because the upper gum tissue tightens around the supporting structures, a closed pocket is produced and the pressure that is caused subsequently leads to considerable pain.

The foregoing considerations indicate that diet is an important factor in preventing and in combating inflammation of the oral tissues and suggests that carious lesions may be an evidence of malnutrition and that further progress of this disease can be checked by proper diet.

Although the dietary management has been useful as a mode of treatment, it should be advocated most strongly as a preventive measure. Dietary management should most certainly begin with the pregnant woman, not only because of the most immediate effect on herself but also because of the action on the fetus. Subsequent proper systematic nourishment of the child may lead to a decreased incidence of oral inflammation and possibly of dental caries.

A 2 per cent solution of Bismarck brown, prepared in one of two ways, is suitable for a disclosing stain. Bismarck brown, 2 gm., is dissolved in 100 c.c. of (1) a 25 per cent (by volume) solution of glycerol; or (2) a 20 per cent solution of alcohol. The second solution stains plaques very rapidly and intensely. It has the disadvantage of occasionally staining the clean enamel a pale shade of brown. The first solution stains the plaques more slowly, but quite intensely, and it does not stain enamel. Either solution will impart a brown color to inflamed gingival tissue. The Bismarck brown stain is better for our purposes than Skinner's disclosing solution because the color remains for from thirty to sixty minutes. All mouths should be brushed for one and one-half minutes with a soft toothbrush and

water before the stain is applied. This treatment does not remove plaques, but it does remove the thin film of mucin present on all

gingival tissue and on all teeth, which would otherwise acquire a brown color, this fact leading to erroneous conclusions.

## SURGICAL TREATMENT OF ACCIDENTAL WOUNDS OF THE MOUTH AND FACE, WITH SPECIAL REFERENCE TO THOSE COMPLICATED BY BONE INJURY\*

By ROBERT H. IVY, M.D., D.D.S., F.A.C.S., Philadelphia, Pa.

THE increasing frequency of injuries to the soft tissues and bony framework of the face, especially as the result of automobile accidents, has created a special field for cooperation of the surgeon and the dentist, a field which proved its value in the treatment of war injuries of the face and jaws. There are very few men with the skill and inclination to handle alone all the aspects of these cases, including the surgical, the dental and the prosthetic.

Unfortunately, it has been rather difficult to find men practicing dentistry, even though they are specialists in prosthodontia, who are sufficiently familiar with the prosthetic requirements of these cases, or who are able to devote sufficient time to the making of necessary appliances. The surgeon is, therefore, frequently handicapped by the lack of proper splints and other apparatus, and it has often been necessary to resort to expedients or makeshifts which served the purpose in a way, although, with the proper cooperation, the case could have been handled much more efficiently.

At the Walter Reed General Hospital, a very different state of affairs exists from that obtaining in civilian

practice. Here, there is a personnel thoroughly equipped to handle these injuries of the face and jaws from the standpoint of the surgeon, the dental surgeon and the prosthetist. The officer responsible for splints knows just what is wanted and what will work best in a given case, and he is able to turn out the appliance in the shortest possible time. Those interested in this aspect of the work should consult the articles on maxillofacial prosthesis, by Roy L. Bodine,<sup>1</sup> the first published in November, 1928.

Injuries may vary from slight scratches and bruises to total destruction of a part. They may be limited to the soft tissues alone or may also involve underlying bones.

Wounds may be divided into four general classes:

1. An incised wound is one in which the tissues are clean cut by a sharp object, without bruising. The vitality of the tissues is but little impaired, and conditions are most favorable for healing without sepsis.

2. A lacerated wound is one in which the tissues and skin edges are torn, rather than clean-cut.

\*Read before the American Society of Oral Surgeons and Exodontists, Washington, D. C., Oct. 4, 1929.

1. Bodine, R. L.: Maxillofacial Prosthesis, *Internat. J. Orthodon.*, 14:998 (Nov.) 1928.