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Vitamin C and Stomatology: A Mouthful of Evidence

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Introduction

May I take this opportunity to applaud the Alacer Corporation for providing the privilege of examining the versatility of vitamin C and its many faces. Also, I should like to add my personal gratitude to Mr. Jay Patrick, the President, for the chance of sharing in this singular experience. And most importantly, it should be noted that this special event permits us the rare opportunity to examine the relationship of the ascorbates to oral health and sickness.

What, in fact, are the reasons for looking at vitamin C in stomatology? There are at least three. Firstly, it involves the history of scurvy. Secondly, it allows a demonstration of the unusual ecologic possibilities inherent in the oral cavity. Lastly, but by no means least, the diagnostic potential of this organ.

Historical Perspectives

The problem of what later came to be known as scurvy was evident way back in the 1440s by the seamen and surgeons on long voyages. One Naval surgeon who became particularly interested in this malady was James Lind, now the most celebrated name in the history of this subject.

As a surgeon in the British Royal Navy, it was during an outbreak of what came-to-be-known as scurvy, that Lind carried out his famous experiment — probably the first controlled trial in clinical nutrition, or even in any branch of clinical science.

He studied a group of scorbutic sailors under what today would be viewed as an acceptable double-blind experimental design. Without delving into all the particulars, it became evident that this terrible syndrome responded almost magically to the consumption of oranges and lemons.

What is relevant here is that Captain Lind emphasized the point that one of the three major clinical signs was spongy gums (an unsophisticated label for periodontal disease).

All of this occurred in the 1750s. Hence, the point should be emphasized, as far as I am concerned since I was not present, this is all second-hand information. However, I should underscore that many of my colleagues tell the story as if they were there. I just thought you ought to know that.

The Ecologic Model

The 1800s were good times. Some of the fundamental principles needed in the genesis of twentieth century modern medicine came on the scene.

Louis Pasteur focused our attention on germs and their relationship to health and disease. He emphasized that microorganisms play havoc only when they light on poor soil. Unfortunately, some of us have twisted this about so that it has come to sound like the germs really and singly are the culprits in ill-health.

It was about this time that Claude Bernard appeared on the scene and identified the ingredients of the "soil". He made it clear we are surrounded by an (external) world filled with many and different environmental challenges. How we fare is in part a function of the number and severity of this bombardment in the light of an internal world (the milieu interieur).[1] Much time and effort was spent in those early days describing the mechanisms underlining the world within. Importantly, it became obvious that the most critical element of this inner environment was its steadiness. For us, we can call it soil or internal world or even host resistance/susceptibility, tissue tolerance, or immune

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systems. Call it what you will, it permits us for the first time, to explain why seemingly similar people with seemingly similar problems have different clinical pictures and respond so often and so differently to seemingly similar treatment.

From all of this has come a new and more meaningful philosophy of health and sickness. It is called ecology. What it says in simple terms is that our medical problems are of a multifactorial nature. What comes out as health or sickness (on the right side of the equation) is in part a function of the many and different environmental challenges (on the left side). But, as or more important as the case may be, what appears as health and sickness (on the right side of the formula) is equally a function of the world within, the milieu interieur.

The oral cavity is unique in that it is the best single site to study the relationship of the environment and the host to health and illness. One can readily improve the oral environment by scaling and polishing the teeth on one side while ignoring the contralateral. Serial comparisons later provide an opportunity to study the benefits of this common dental procedure called prophylaxis. Conversely, one can (orthodontically) band teeth on the one side of the mouth leaving the other quadrants untouched. By this technique, it is possible to evaluate the relative irritation of banding. Hence, by these two techniques, one can favorably and unfavorably modify the oral environment without altering in any way the internal world. This, in fact, is what regularly occurs in the real (dental) world.

It is also possible (though generally not employed) to provide half a group of subjects with a systemic agent (e.g. vitamin C) while administering an indistinguishable placebo to the other half of the group. Parenthetic mention should be made that we have not yet learned how to administer vitamin C to one half the mouth! Be that as it may, by this method, it is possible to evaluate the very same oral tissues in terms of the influence of this particular vitamin.

Finally, the ecologic model allows the combination of all variables. We can study the effects of prophylaxis or no prophylaxis, orthodontic banding or no banding, in individuals provided with vitamin C versus a placebo. Hence, we have here the extraordinary opportunity of evaluating all of the possibilities in the ecologic equation.

Utilizing this formula, in our laboratories, the problem of prophylaxis in presumably healthy people with and without vitamin C supplementation was examined. We discovered (what is already known) that when one simply performs prophylaxis, there is significant gingival improvement. In this particular experiment,[2] it amounted to a 30% reduction in gingival inflammation. We also found (what is not generally known) that when one provides vitamin C and no prophylaxis, there is a reduction in gingivitis of approximately 60%. In other words, vitamin C without prophylaxis was more effective than prophylaxis without vitamin C. Finally, the evidence suggests that when one scales and polishes the teeth and provides the ascorbates, the success is of anorder of 70%!

These same relationships have been evaluated with other oral characteristics (i.e. periodontal sulcus depth[3] and clinical tooth mobility[4]). While the actual numbers are obviously different, the patterns are all the same.

Notwithstanding the ecologic studies just cited as well as other similar observations, the present official thinking is based on two epidemiologic studies. Russell in 1963 summarized the results of the surveys conducted under the auspices of the Interdepartmental Committee on Nutrition for National Defense (ICNND), which recorded the nutritional and oral health status of selected samples of the population in eight countries.[5] The assessment of nutritional deficiencies was based on clinical examinations and on biochemical tests of blood and urine in a small subsample. Serum levels of ascorbic acid were used in the ICNND studies to ascertain deficiency levels. Russell concluded that age and oral hygiene contributed most to the variance in PI (Periodontal Index) scores; an association between ascorbic acid deficiency and increased PI scores could not be established.

In the Ten-State Survey, a "weak" correlation was reported between the ascorbates and the presence of periodontal

disease.[6]

Now to the most recent and most official pronouncements.

Ismail and his colleagues[7] investigated the association between the reported levels of dietary ascorbic acid intake and the presence of periodontal disease in a representative sample of the U.S. population provided by the first National Health and Nutrition Examination Survey (NHANES I), from 1971 to 1974. The NHANES I survey was a comprehensive review of health and nutrition in more than 20,000 individuals, aged 1 to 74, in the continental United States. Data was collected from 8,609 dentulous (with teeth) persons, aged 25 to 74 years, who received a dental examination during NHANES I and with whom a 24-hour dietary recall interview was conducted. The purpose of this analysis was to investigate the association between periodontal disease and reported dietary ascorbate intake, and to determine whether a more-than-recommended daily intake of ascorbic acid was associated with better periodontal health.

Periodontal disease status (Periodontal Index, PI), and oral hygiene state (Simplified Oral Hygiene Index, OHI-S), in addition to other oral and dental health assessments, were measured by ten trained dentists at 65 locations during the four years of the NHANES I survey.

Ascorbic acid intake was calculated from the foods reportedly consumed by each individual in the study during the preceding 24 hours. To insure the greatest possible accuracy, the interviews were conducted by persons trained in gathering dietary data. Parenthetic mention should be made that, in this report, the term "dietary ascorbic acid" refers to ascorbate reportedly consumed in the 24-hour dietary recall, without considering vitamin supplements.

The conclusions are complex and convoluted. They are summarized by the two large statements splashed in appropriate places in the original report. In the words of these investigators, "Among those who reported taking vitamin supplements, there is nothing to support any association between levels of ascorbic ingestion and periodontal health ... Dental practitioners are better advised to concentrate on plaque control rather than vitamin C supplements to prevent and control periodontal disease in their patients."

This conclusion is in part the bases of the current recommendation of the Council on Dental Therapeutics of the American Dental Association.[8] And, has been the conventional justification for minimizing vitamin C in oral health and sickness.

In all fairness, there are other and more sophisticated studies. One will be cited here. It is the work of Penelope Leggott and her associates at the University of California, San Francisco School of Dentistry and the U.S. Department of Agriculture Western Nutrition Research Center in San Francisco.[9]

Eleven healthy, non-smoking men, aged 19 to 28 years, ate a rotating seven-day diet adequate in all nutrients except ascorbic acid. This basal diet, which contained less than five milligrams per day of vitamin C, was supplemented with 60 mg daily of ascorbate for two weeks, none daily for four weeks, 600 mg per day for three weeks and zero daily for four weeks. Plasma, urine and leukocyte ascorbate levels, Plaque Index, Gingival Index, Bleeding Index and probing depths were monitored throughout the study. A uniform oral hygiene program was maintained in which instructions were reinforced biweekly. In other words, the external oral challenges were minimized.

Ascorbate concentrations in body fluids and leukocytes responded rapidly to alternatives in vitamin C intake. No mucosal pathoses or changes in plaque accumulation or probing depths were noted during any of the periods of depletion or supplementation. However, measures of gingival inflammation were directly related to the ascorbic acid status. The results suggest that the ascorbates may influence early stages of gingivitis, particularly crevicular bleeding.

The Mouth as a Diagnostic Tool

Obviously, the final chapter on the ascorbates in general as well as oral health and sickness has not been written. Relevant here is the fact that it has not and will not until greater attention is relegated to the measurement of vitamin C in one or another body fluids or tissues. Those interested in the measurement of vitamin C

know full well that, for research purposes, this can be readily done (e.g. saliva, tears, urine, etc.).

In the more practical world, there are currently two vitamin C tests. One, the older and better-known, and relatively simple is the assessment of ascorbic acid in the plasma or serum. Obviously, much has been written about this tool since it has long been utilized. The other is more recent and has been less examined. It is also more expensive and difficult to perform. It consists of the measurement of vitamin C in the white cells of the blood. These two procedures are now well-established. What is still not clear are the acceptable "normal" ranges and, more importantly, the optimal concentration.

Also, what is not appreciated, is that there has been for some time, since the 1960s, a simple and inexpensive ascorbate stomatologic measurement. It is referred to as the Lingual Ascorbic Acid Test (LAAT).

Because this test has not been well publicized, it is appropriate that we here consider its virtues and limitations.

To perform the procedure, one need only to drop one minim of a 1/340 N 2,6 dichlorphenolinodolphenol (dark blue) solution upon the dorsum of the tongue. A stopwatch is set in motion and the number of seconds recorded for the blue color to vanish. The more vitamin C in the tongue tissue, the faster is the reduction of the dye to a colorless state.[10]

We have examined many of the technical features of this procedure in a series of reports. For one, the test is highly consistent. A study of 526 lingual vitamin C test duplicate pairs by three different observers discloses that the procedure is highly reproducible.[11] The majority of duplications show an error less than four seconds. In other words, when the same or different examiners perform the test minutes apart, one can expect a variation of not more than approximately four seconds. This obviously is, in part, a function of setting off the time clock.

LAAT also fluctuates minimally from time to time.[12] For example, duplicate lingual vitamin C tests were performed two hours apart in 21 subjects. The same procedures were carried out in 97 persons twice in three days and in 25 participants at a three week interval. In other words, ascorbic acid state seems ordinarily fairly constant.

Mention was made earlier that the most popular present procedure is plasma vitamin C. Accordingly, the relationship of the lingual vitamin C test scores and plasma ascorbic acid concentration was studied in 1,194 subjects.[13] The evidence suggests that there is a significant negative correlation between these two test procedures. Those with the highest plasma levels (in mg%) are most often associated with the shortest (in seconds) lingual times. It is of interest that, within the limits of this study, the correlation is greater when the two test techniques are performed under fasting conditions. As has been mentioned earlier, it is generally known that the plasma state is more a measure of diet than tissue concentration. This just-cited finding once again suggests that the tongue test may be a better reflection of tissue state.

Interestingly, this lingual test has also been compared to the concentration of vitamin C in the skin. In this connection, 616 subjects participated in a study designed to examine the relationship of the lingual vitamin C test scores and intradermal ascorbate test times.[14] The evidence from the entire sample suggests that there is a statistically significant positive correlation. In other words, the longer the lingual time (in seconds), the longer the intradermal time (in minutes). The correlation is heightened when the relationship is studied under fasting conditions. Moreover, the limited evidence presented suggests that the connection between fasting intradermal and lingual time is higher than the correlation of lingual time and plasma ascorbic acid. Here again is another confirmation that the tongue and skin times are probably more a measure of tissue vitamin C than is plasma ascorbic acid.

How sensitive is this procedure?

The daily intake of citrus juices, oranges, and vitamin supplements along with the plasma ascorbic acid level, intradermal time, and lingual vitamin C test scores were studied in 266 subjects.[15] The evidence suggests, in general, that there is a correla-

tion between vitamin C state and daily ascorbate consumption. This is particularly true under fasting conditions and more especially when plasma ascorbic acid is utilized as the vitamin C measure. Phrased another way, here is even more evidence that the plasma level is more a function of diet and the lingual test is a better barometer of tissue state.

What about controlled studies with ascorbate supplementation?

The LAAT scores were studied three weeks apart under fasting conditions in subjects receiving placebo versus vitamin C (100 mg three times daily) supplementation.[16] It is abundantly clear that a statistically significant reduction in lingual time occurred only in the ascorbic acid supplemented group. In fact, the initial time of 26 seconds declined to 16. The decrement was of an order of 38%. What is especially exciting is that this higher-than-R.D.A., but still-not-very-large-C-supplementation, influenced favorably (reduction) the lingual test score in 96% of the cases!

It should come as no surprise, with the increasing awareness of the importance of lipid metabolism in health and sickness that burgeoning studies are available on just about every popular biochemical test. The one receiving the greatest attention has been serum cholesterol. For these reasons, the lingual vitamin C test scores, plasma ascorbic acid levels and serum cholesterol were correlated under nonfasting conditions in 127 presumably healthy dental students. There is no question but that a statistically convincing positive relationship prevails between the nonfasting serum cholesterol and the nonfasting LAAT scores. Thus, the higher (the poorer) the serum cholesterol, the higher (the poorer) the lingual vitamin C scores. Interestingly, no such relationship prevails when nonfasting plasma ascorbic acid levels and nonfasting serum cholesterol are studied. Here again is more evidence of the potentially greater utility of the tongue tissue test.

Obviously, it would be well to ferret out the incidence and prevalence of the vitamin C state in the general community. Limited studies have been done. The nonfasting lingual vitamin C test scores were determined in 1305 employees in the culinary industry and in 762 child dependents of employees in the retail clerks community.[18] Utilizing a physiologic standard of less than 20 seconds, 51% of the group showed scores which can be regarded as marginally suboptimal and 21% of the sample display values consistent with a clinical ascorbic acid deficiency. It looks, from these figures, like an epidemic!

As one might expect, considerable consideration has been given to the utility of LAAT in clinical medicine and dentistry. One hundred two subjects participated in an experiment in which vitamin C state was measured under fasting conditions by means of plasma ascorbic acid level and by lingual tissue time technique.[19] The gingiva was graded in the twelve anterior teeth on a four point scale. The data suggest that there is a statistically significant negative correlation between gingival health and plasma ascorbic acid level. In other words, the higher the plasma ascorbic acid level, the better the gingival condition. Within the limits of this study, the information also indicates a statistically convincing positive correlation between lingual vitamin C test time and gingival state. In other words, the longer the lingual time, the poorer the vitamin C state and the poorer the gingival health. Parenthetic mention should be made that these findings are at variance with the governmental conclusions cited earlier in the ICNND surveys and in the NHANES I reports.

We have pursued these clinical studies with other oral parameters. The findings with sulcus depth[20] are precisely those just-mentioned for gingival inflammation. In the case of clinical tooth mobility,[21] only the tissue relationships (LAAT studies) are significant.

One of the continuing great mysteries of stomatology is the well-established awareness that in many instances, with advancing age, there is increasing alveolar bone loss.[22] There seems to be a more orderly statistical connection between advancing age and alveolar bone loss as viewed by the tongue test. In other words, as vitamin C state becomes progressively poorer, alveolar bone loss in the aged increases.

Evidence that oral hygiene is a significant factor in the genesis of periodontal pathosis is well-established.[23] Interestingly,

these very same reports suggest that "oral hygiene" may have double meanings. On the one hand, oral hygiene signifies the state of tooth cleanliness; and, on the other, the art of tooth cleansing. Hence, things equal to the same things become equal to each other. Thus, often one assumes that the art of cleansing is indeed the cause of the state of cleanliness. This semantic trap may be central to an understanding of the etiology of periodontal disease.

For these reasons, we have examined the relationship between vitamin C state and oral hygiene (the state of cleanliness) and a particular characteristic of oral hygiene (tartar). One hundred two subjects participated in an experiment in which vitamin C state was measured under fasting conditions by means of plasma ascorbic acid level and by the lingual test technique.[24] Mean oral hygiene scores were graded in the 12 anterior teeth. Subgroup analyses within restricted age groups reveal significant correlations between vitamin C state (plasma ascorbic acid level and lingual test) and oral hygiene. In other words, the state of cleanliness worsens in a more orderly fashion in the subjects with the relatively poorest vitamin C state as judged by the LAAT technique.

Studies have also been performed on other measures of oral hygiene. The evidence suggests that there is a statistically significant relationship between vitamin C as measured by plasma ascorbic acid and oral calculus when the entire sample is studied.[25] Subgroup analyses within restricted age groups reveal that the most significant relationship between age and calculus exists in the individuals with the longest lingual times and therefore the poorest vitamin C state.

Can one utilize the ascorbate state as a predictor of the initial oral condition and subsequent therapeutic success?

Twenty-five presumably healthy subjects participated in this experiment to determine the predictive potential of an ascorbic acid measure (the lingual vitamin C test) in gingival state following oral prophylaxis.[26] It is clear that the subjects with the better (shorter) lingual time have better gingiva prior to therapy. Additionally, the data indicate that improved gingival results follow in subjects with improved vitamin C state. Finally, the more restricted the vitamin C test range, the greater the predictiveness. Incidentally, this very same experimental design was performed utilizing periodontal sulcus depth as the clinical parameter.[27] The results are essentially the same with the one exception that gingival inflammation proved to be more predictive.

Other experiments and subsequent publications are available. One example includes 42 students who participated in a study to examine the effect of a multivitamin-mineral versus placebo supplement upon vitamin C state as judged by the lingual vitamin C test time.[28] Two conclusions appear in order. First, the LAAT (indicating improvement in vitamin C state) was reduced (five seconds) only in the group receiving the multivitamin/mineral supplement. Additionally, within this group, the lingual time was reduced almost double (nine seconds) in those subjects with relatively poor initial vitamin C state (longer lingual time). In another instance, a statistically significant improvement in tissue ascorbic acid was noted following dietary protein supplementation for four days in relatively young, healthy men.[29] Ascorbic acid status was essentially unchanged with the placebo supplement.

An attempt has been made to develop the physiologic lingual vitamin C time in a group of presumably healthy males.[30] This was accomplished by selection on the basis of rigid health criteria. Thus, individuals with symptoms and signs of disease were progressively eliminated. The evidence, within the limits of this investigation, suggests that the physiologic range for the lingual vitamin C test may be quite restricted, approximately 15 to 25 seconds. Parenthetic mention should be made that these conclusions are consistent with the earlier values derived from our predictive studies.

In summary, from this evidence, it is fair to conclude that the lingual vitamin C test is a relatively simple, inexpensive, and reasonably accurate screening procedure for the detection of hypovitaminosis C. It is, of course, hoped that this discussion will catalyze additional interest in the development of this procedure and its

clinical utilization.

Summary and Conclusions

Historical accounts are clear. One of the hallmarks of scurvy is gingival symptomatology. Notwithstanding the ecologic evidence, the prevailing trends confirm little interest in the relationship of the ascorbates to periodontal health and sickness. A diagnosis of diabetes mellitus would never be made without a blood glucose test. Yet the suspicion of scurvy (when it is made) is purely by clinical means. The suggestion is made for a simple, quick, and inexpensive (one-penny-one-minute) vitamin C tongue diagnostic test.

Let us put it another way: A scene in a doctor's office ...

The physician has just completed an oration about the merits of the well-known well-balanced diet. The patient rises, walks to the door, opens it, and then turns to the doctor.

Patient: By the way, Doctor, do you ever encounter any vitamin C problems?

Doctor: No, not really.

Patient: Have you ever thought it necessary to measure vitamin C?

Doctor: No, why?

Patient: Is that not a good way not to see any problems?

The doctor, stunned, turns to the audience, as the curtain falls.

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