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SUBCLINICAL SCURVY AND SUBCLINICAL TOOTH MOBILITY*

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Introduction

The evidence is abundant that, long before there are *signs* (objective and observable proof) of disease, *symptoms* (subjective complaints by the patient) are already present. True enough, the symptoms are usually nonspecific in that the very same complaints may be associated with a host of disorders. Moreover, since symptoms are subjective, it is extremely difficult, if not impossible, to equate them. The evidence is also clear that, before there are *symptoms* of disease, *histochemical cellular changes* have already occurred[1].

Recognition of this sequence of events has led to a relentless search to develop increasingly sensitive tests so that the disease mechanism can be detected at the earliest possible stage — at a time when the pathophysiologic process can still be reversed and the tissues restored to complete health.

The thesis set forth here is true of disease processes in general. It follows, then, that it should apply in the case of the ascorbic acid deficiency state.

There are countless descriptions of so-called *classical* scurvy in the standard textbooks[2, 3, 4, 5]. Little mention is made of the fact that, long before classical symptoms and signs appear, changes have already occurred in the hinterland — in the cells themselves. A number of tests are available, though strangely enough not often used in clinical practice, which measures the ascorbic acid content of the plasma[6, 7], serum[8, 9], whole blood[10, 11], leucocytes in the blood [12, 13], urine[14, 15], and skin[16, 17, 18].

At the same time, there are numerous descriptions of tooth mobility in the literature[19, 20, 21, 22]. Almost without exception, tooth mobility in clinical practice is determined by how much, in some cases in millimeters, a tooth can be moved with digital pressure. It should be evident that, long before a tooth is *clinically* mobile, *subclinical* tooth mobility must already be present. Techniques are available for determining *subclinical* tooth mobility[23, 24, 25, 26, 27, 28, 29, 30, 31, 32].

Two independent factors have been brought together in this research project. The detection of *subclinical* scurvy (via the intradermal decolorization test and fasting plasma ascorbic acid level) and *subclinical* tooth mobility (by means of the Muhlemann procedure) will be investigated to answer the following two questions:

1. What is the effect of massive doses of ascorbic acid for long periods of time upon *subclinical* tooth mobility in a presumably healthy subject?
2. What is the effect of massive doses of ascorbic acid for long periods of time upon *subclinical* tooth mobility in a *subclinically* ascorbic acid deficient subject?

Method of Investigation

Four clinically healthy subjects (ArJi, EmCh, JoMa, and JoDu) were studied for a sixteen-week period. The first two subjects (ArJi and EmCh) showed neither clinical nor laboratory evidence of an ascorbic acid deficiency state. The remaining two (JoMa and JoDu) demonstrated neither clinical symptoms nor signs but did show laboratory evidence of a marginal ascorbic acid deficiency.

The ascorbic acid status of each of these subjects was determined by the 2,6-dichlorophenolindophenol decolorization procedure [16, 17, 18]. This method consists of introducing a measured amount of dye (0.05 cc.) intradermally. The time required for decolorization of the dye is an index of the ascorbic acid content of the tissues. The longer the decolorization time, the less ascorbic acid in the tissues. Conversely, the shorter the decolorization time, the greater the tissue content of ascorbic acid. The fasting plasma ascorbic acid level was determined according to the method of Mindlin and Butler[6]. It was deemed advisable to utilize the 2,6-dichlorophenolindophenol test because the evidence suggests[18] that this testing procedure provides a highly sensitive index

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of the *tissue* ascorbic acid status. However, to corroborate the skin time scores, the better-known fasting *plasma* ascorbic acid levels were also included.

Tooth mobility was recorded in hundredths of a millimeter. This was accomplished by the use of the Muhlemann periodontometer[32, 33]. The technique is one of applying a known force, in this case 500 grams, for a three-second period to the surface of a tooth. The amount of tooth deflection is then recorded. Actually, the study consisted of applying a 500 gram force to the labial surface of a tooth for a three-second interval and measuring palatal deflection. Then, after a three-second rest period, the same force was applied to the palatal surface of the same tooth and labial deflection was recorded. The entire procedure was then repeated as shown in Fig. 1. This same method was used in the determination of tooth mobility in the four maxillary incisor teeth.

At the initial visit and at every succeeding session during a sixteen week period, unless otherwise indicated, the following items were recorded: (1) photographs of the anterior teeth and associated periodontal structures, (2) periodontal appraisal by way of a modification of the P. M. A. index[34], (3) fasting plasma ascorbic acid level, (4) fasting intradermal ascorbic acid decolorization time, (5) tooth mobility measurements of the four maxillary incisor teeth, (6) a history of oral and extraoral bleeding and general health, (7) full mouth periapical roentgenograms were taken at the first and sixteenth weeks, and (8) extensive personal and family medical histories were recorded at the initial visit.

Tooth mobility of the four maxillary incisor teeth and the ascorbic acid status were measured initially before vitamin supplementation and then at each subsequent visit. For the first eight weeks, each of the subjects received 1000 mgm. of ascorbic acid daily in four divided doses of 250 mgm. each. For the last eight-week period, the subjects received no vitamin supplementation.

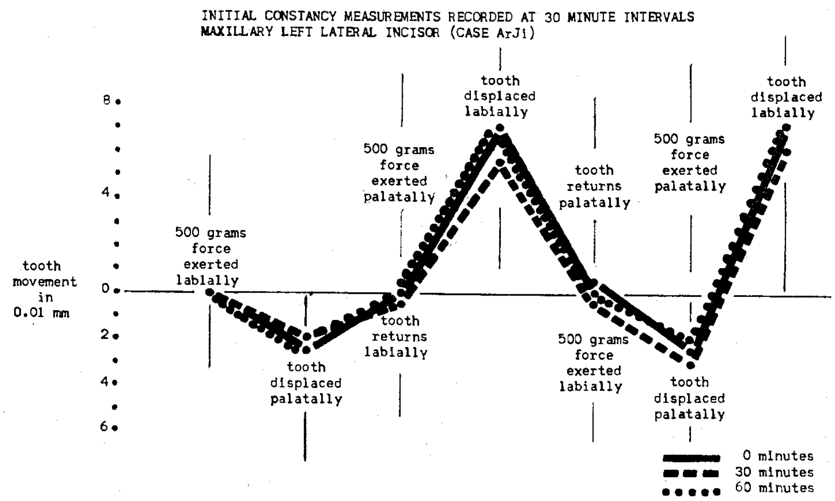

Fig. 1. The procedure followed in the measurement of subclinical tooth mobility.

The study reported here will only be concerned with an analysis and the relationship between the ascorbic acid status and tooth mobility as determined by palatal deflections.

Results

Case Report No. 1

ArJi is a 34 year-old dental practitioner in presumably good health. The subject reported that, on occasion, he suffered with migraine and hay fever. Figures 2 and 3 show the clinical and roentgenographic picture of the anterior teeth and associated periodontal structures. The general statement can be made that they appear "normal" in all respects. Figure 4 shows the fasting plasma ascorbic acid values and the intradermal scores at each of the visits. It is clear from this chart that the fasting plasma ascorbic acid level, initially, was .90 mgm. percent and the initial fasting intradermal test time 12.5 minutes. According to known standards[16, 17, 18], these values are indicative of an *adequate* ascorbic acid status.

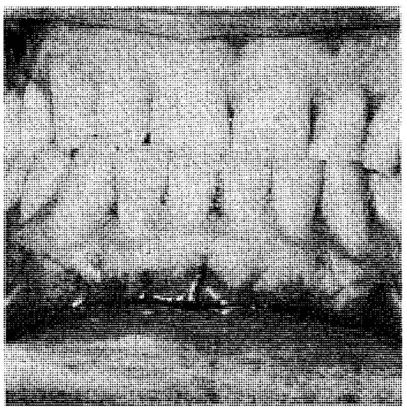

Fig. 2. The clinical picture of the anterior teeth and associated periodontal structures of a 34 year-old, presumably healthy, individual.

It is evident from Fig. 4 that fluctuations did occur in both the plasma levels and intradermal times during both the supplementation and no supplementation periods. It appears that the values did not differ significantly between the first and second eight-week periods. In other words, the conclusion seems evident that the levels were not markedly affected by the massive doses of as-

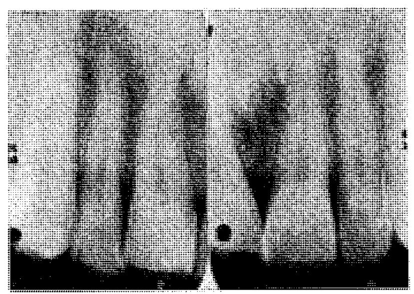

Fig. 3. The roentgenographic picture of the maxillary anterior teeth and associated periodontal structures of a 34 year-old, presumably healthy, individual.

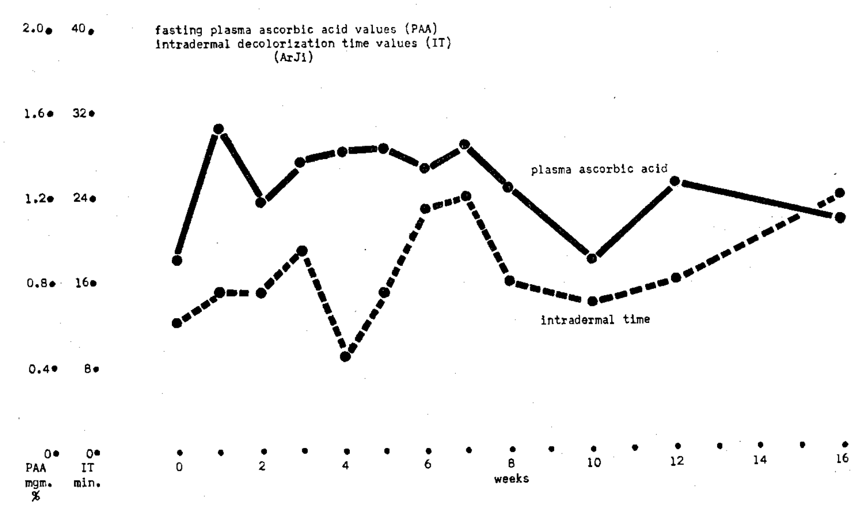

Fig. 4. A sixteen-week record of the fasting plasma ascorbic acid levels and intradermal times. The findings at "zero" week of .90 mgm. percent and 12.5 minutes are indicative of an adequate ascorbic acid status. The determinations at the first through eighth weeks show the values during the period when the subject took 1000 grams of ascorbic acid daily. No vitamin supplementation was given during the last eight weeks.

corbic acid. This is quite understandable since the subject did not require additional vitamin support as evidenced by the initial values which were indicative of adequate score increased to 19 minutes. Interestingly enough, it was at exactly that time that the subject developed a urinary tract infection. Worthy of mention is the fact that, with the

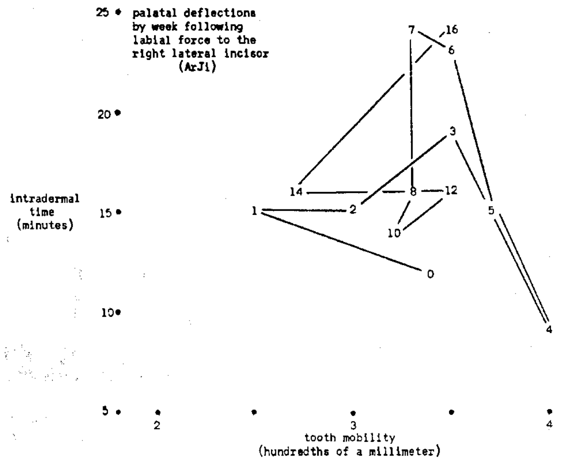

Fig. 5. The palatal deflections, by week, following a labial force of 500 grams to the right lateral incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

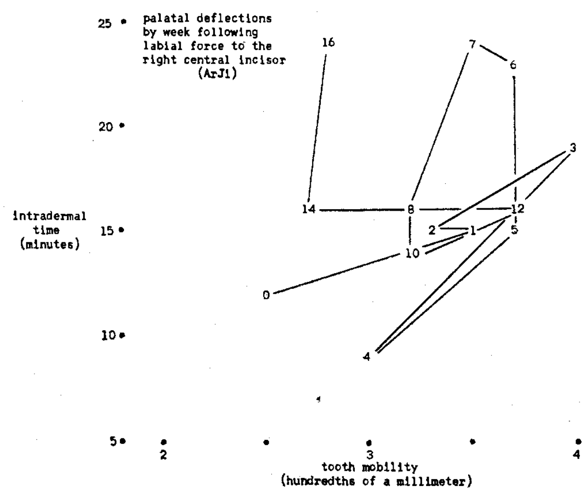

Fig. 6. The palatal deflections, by week, following a labial force of 500 grams to the right central incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

ascorbic acid status.

One can observe (Fig. 4) that there are instances when the intradermal time increased considerably. This can be interpreted to mean that the level of ascorbic acid was low in the tissues at that particular time. For example, at the third week, the intradermal subsidance of the infection, the intradermal time dropped precipitiously from 19 to 9 minutes. It should be recalled that, prior to the onset of the study, the subject indicated a history of frequent migrainous attacks and hay fever. These same headaches and allergic attacks occurred during the experiment. The possibility exists that some of the other intradermal test time fluctuations might have paralleled the migrainous attacks. It appears from a study of Fig. 4, and this point will become more apparent in Case Report No. 2, that stress increases the utilization of ascorbic acid. Thus, the level in the tissues decreases during stress situations.

Figures 5-8 show the tooth mobility scores, on the basis of 156 individual measurements, for the right lateral and central incisors and the left central and lateral incisors (No. 7, 8, 9, 10) prior to the start of vitamin therapy, during the eight weeks with ascorbic acid supplementation, and for the eight weeks without medication.

Several observations are of interest. *First*, the initial tooth mobility differed among the

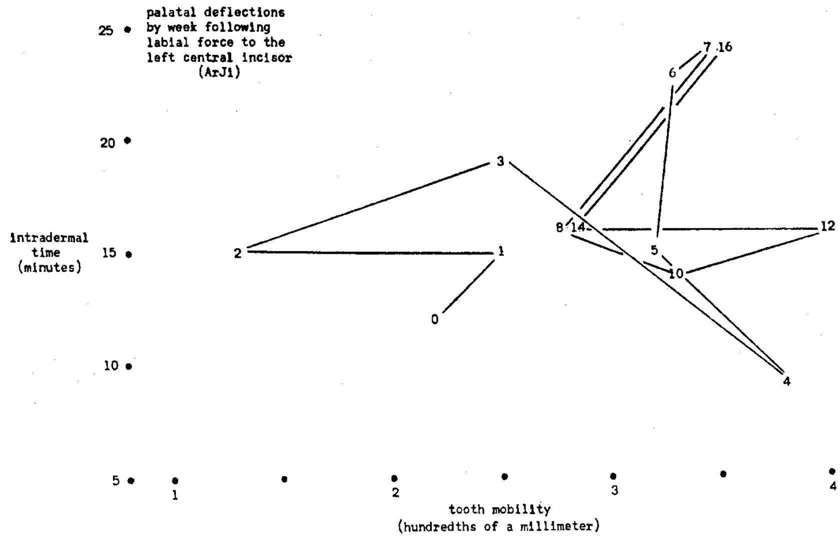

Fig. 7. The palatal deflections, by week, following a labial force of 500 grams to the left central incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

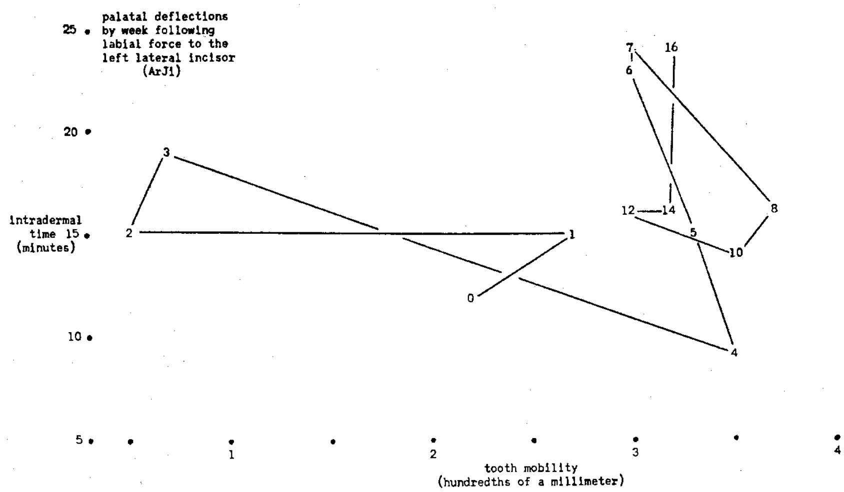

Fig. 8. The palatal deflections, by week, following a labial force of 500 grams to the left lateral incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

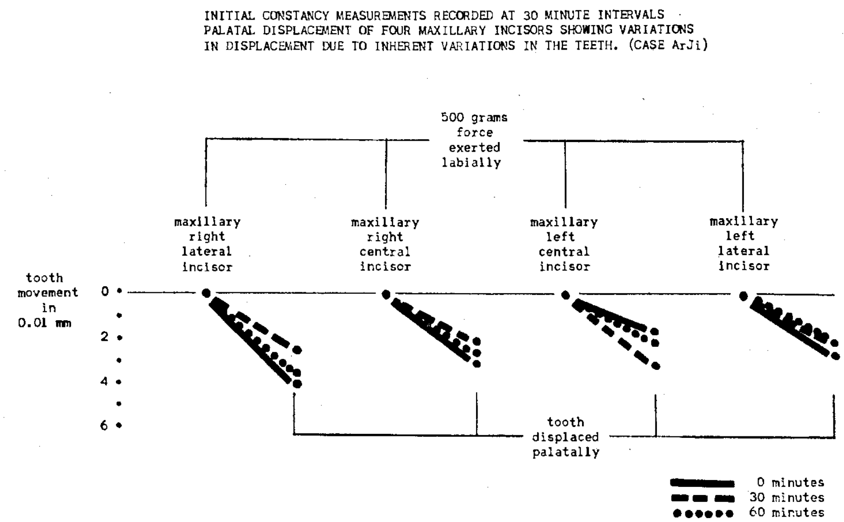

Fig. 9. Initial constancy measurements recorded at 30 minute intervals showing the palatal displacement of the four maxillary incisor teeth due to inherent variations.

four maxillary incisor teeth (Fig. 9). This is quite understandable since the teeth vary in size, position, and the fulcrum is obviously quite different (Figs. 2 and 3). Support for the contention that tooth mobility is a function of tooth size, position, and rotation center is available in the literature[34, 35]. *Secondly*, it is clear that, from week to week, tooth mobility varied in the same tooth and in different teeth. The explanation for these variations is not entirely available. Certainly, the periodontometer has its limitations and, therefore, there must be an element of error in recording in hundredths and thousandths of a millimeter. *Thirdly*, it is of interest that the overall changes in tooth mobility prior to, during, and after supplementation are small. For example, tooth mobility ranged in the right lateral incisor from .025 to .40 mm.—a difference of only .015 mm. (Fig. 5). For the other teeth, the differences are of a magnitude of

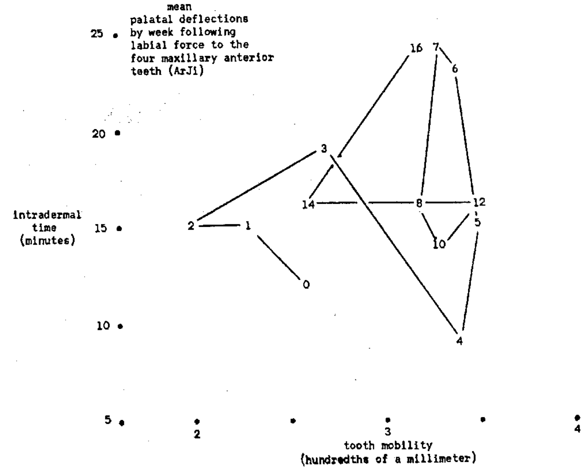

Fig. 10. The mean palatal deflections, by week, following a labial force of 500 grams to the four maxillary incisor teeth individually. "Zero" represents the average tooth mobilty at the initial visit. "One" signifies the mean tooth mobility after one week of vitamin supplementation.

.015 (Fig. 6), .027 (Fig. 7). and .030 mm. (Fig. 8). The greatest range of tooth mobility can be observed in the left lateral incisor. This may be due, at least in part, to the fact that this tooth is in torsiversion (Figs. 2 and 3).

Careful scrutiny of Fig. 5 (indicated on the chart as "O") discloses that tooth mobility in the right lateral incisor was initially .034 mm. After one week of supplementation (noted on the chart as "1") tooth mobility was found to be .025 mm. Following a second week of massive vitamin therapy, the tooth deflection (indicated on the chart as "2") was shown to be .030 mm. A like study of Figs. 6, 7, and 8 confirms the observation that, from week to week, tooth mobility varied very little from that observed initially. Figure 10 depicts the pattern for the composite of the four maxillary incisor teeth. It appears that the overall variations in tooth mobility and intradermal test time are small.

A statistical study of the four maxillary teeth individually and the mean for these same four teeth is depicted in Table 1. The chart shows that, during the first week of ascorbic acid supplementation, there were *no statistically* significant changes in any of the teeth individually or in the average for the four teeth as evidenced by a P ranging from greater than .10 to .50. The evidence is available, but not included here, to show that at no time during the sixteen-week period were there *statistically* significant mobility changes in any of these four teeth.

TABLE 1

Comparison of the significance of palatal deflections initially and after one week of ascorbic acid supplementation

Case Report No. 1 (ArJi)

tooth number(s)	r	t	P
7	—.577	1.220	>.20
8	+.738	1.894	>.10
9	+.272	0.490	.50
10	+.490	0.973	>.20
7, 8, 9, 10	+.187	0.807	>.40

Case Report No. 2

EmCh is a 41 year-old dental practitioner in presumably good health. The personal and family medical histories are noncontributory. Figures 11 and 12 show the clinical and roentgenographic picture of the maxillary anterior teeth and associated periodontal structures. The general statement can be made that they appear "normal" in all respects. Figure 13 shows the fasting plasma ascorbic acid values and intradermal scores at each of the visits. It is clear from this chart that the initial fasting plasma ascorbic acid level was 1.34 mgm. percent and the initial fasting intradermal test time 18 minutes. According to accepted standards, these values are indicative of an *adequate* ascorbic acid status.

It is evident from Fig. 13 that fluctuations did occur in both the plasma levels and intradermal times during both the supplementation and no supplementation periods. It appears that the values for the plasma levels did not differ significantly between the first

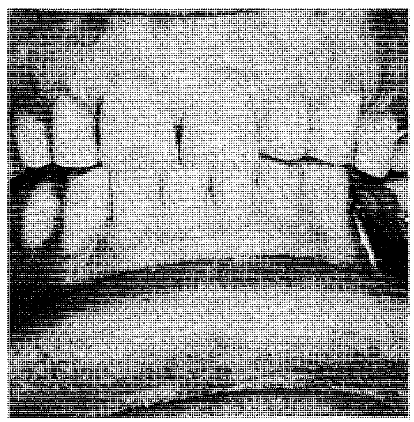

Fig. 11. The clinical picture of the anterior teeth and associated periodontal structures of a 41 year-old, presumably healthy, individual.

Fig. 12. The roentgenographic picture of the maxillary anterior teeth and associated periodontal structures of a 41 year-old, presumably healthy, individual.

and second eight-week periods. However, the intradermal scores were much longer during the no supplementation period. This can be interpreted to mean that the ascorbic acid level in the tissues was lower after

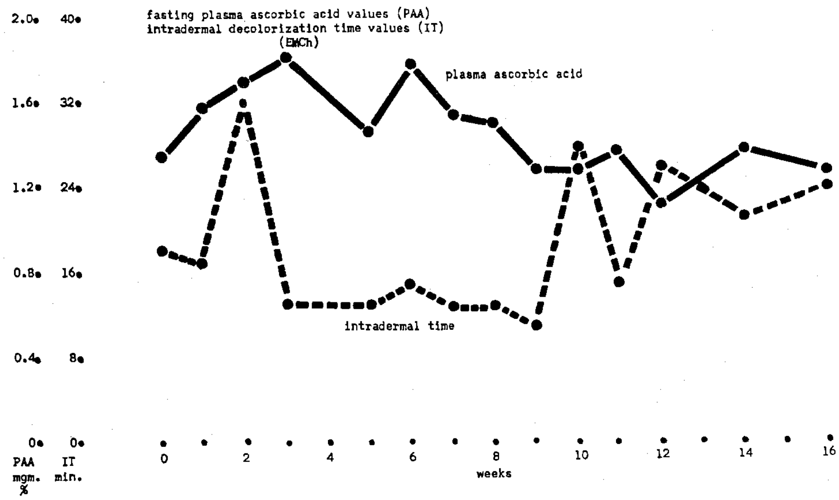

Fig. 13. A sixteen-week record of the fasting plasma ascorbic acid levels and intradermal times. The findings at "zero" week of 1.34 mgm. percent and 18 minutes are indicative of an adequate ascorbic acid status. The determinations at the first through eighth weeks show the values during the period when the subject took 1000 grams of ascorbic acid daily. No vitamin supplementation was given during the last eight weeks.

vitamin support was eliminated. It is of interest that, on two occasions, the intradermal time increased markedly. This occurred during the second week of the experiment at which time the subject developed a serious foot infection. Coincident with subsidance of the infection, the intradermal time decreased as shown by a drop from 32 to 13 minutes. Figure 13 also shows a decided increase in the intradermal time the second week after the vitamin medications were discontinued. Interestingly enough, the subject developed an acute respiratory infection at that time. It appears that the intradermal time is highly sensitive and attuned to any change in stress. The evidence from this subject, as well as the suggestive findings in Case Report No. 1, are presumptive proof for this statement.

Figures 14-17 show the tooth mobility scores, on the basis of 168 individual measurements, for the four maxillary incisor teeth (No. 7, 8, 9, 10) prior to the start of vitamin therapy, during the eight weeks with ascorbic acid supplementation, and for the last eight weeks without medication.

Several observations are of interest. *First,* the initial tooth mobility differed among the four maxillary incisor teeth (Fig. 18). This is quite understandable since the teeth vary in size, position, and the fulcrum is obviously quite different (Figs. 11 and 12). However, it should be noted that the initial variations among the teeth are not as great as those encountered in Case Report No. 1. This is further support that size, position, and rotation center play a role. In Case Report No. 2, the teeth are more nearly alike and the range of tooth mobility is much smaller. *Secondly,* it is clear that, from week to week, tooth mobility varied in the same tooth and in different teeth. The explanation for these variations is not entirely available. Again it is clear that the periodontometer has its limitations and that, therefore, there must be an element of error in recording in hundredths and thousandths of a millimeter. *Thirdly,* it is of interest that the overall changes in tooth mobility prior to, during, and after supplementation are small. For example, tooth mobility ranged for the right lateral incisor across to the left lateral incisor in amounts of .012 (Fig. 14), .018 (Fig. 15), .009 (Fig. 16), and .013 (Fig. 17) mm.

A comparison of these values with those obtained in Case Report No. 1 shows that the individual variations of the four maxillary incisor teeth were smaller than in the preceding case and more consistent. This is graphically demonstrated in Figs. 14-17 by the clustering of the data centrally, unlike those in Case Report No. 1 (Figs. 5-8) which show greater dispersion. Careful scrutiny of Fig. 14 (indicated on the chart as "0") discloses that tooth mobility in the right lateral incisor initially was .038 mm. After one week of supplementation (noted on the chart as "1") tooth mobility was found to be .037 mm. Following a second week of massive vitamin therapy, the tooth deflection (indicated on the chart as "2") was shown to be .042 mm. A like study of Figs. 15, 16, and

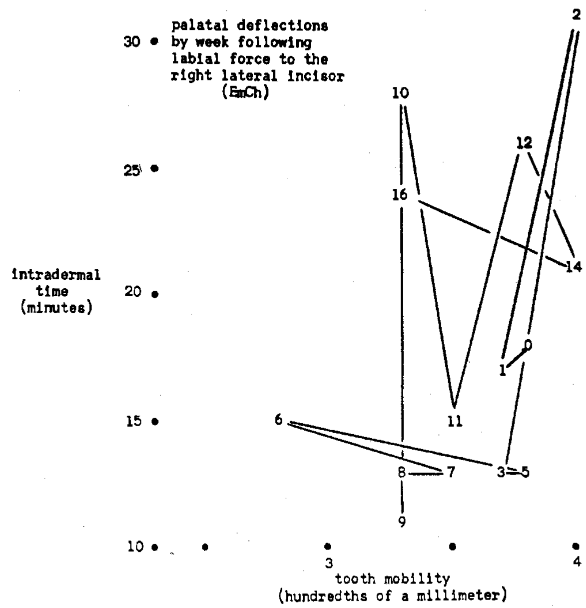

Fig. 14. The palatal deflections, by week, following a labial force of 500 grams to the right lateral incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

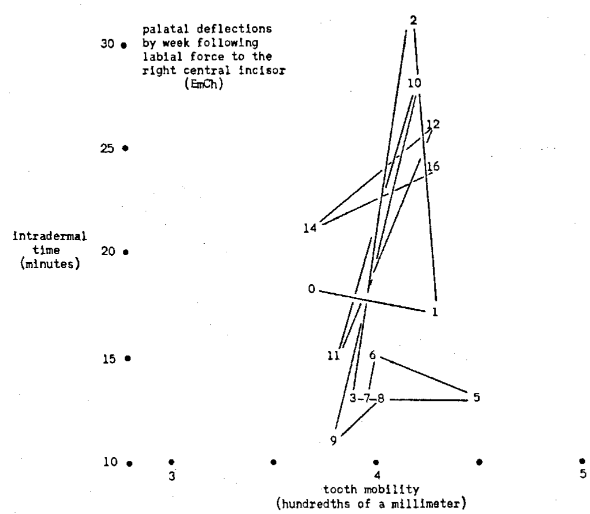

Fig. 15. The palatal deflections, by week, following a labial force of 500 grams to the right central incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

17 confirms the observation that, from week to week, tooth mobility varied very little from that observed initially. Figure 19 depicts the pattern for the composite of these four maxillary incisor teeth. Once again, it appears that the overall variations in tooth mobility and intradermal test time are small.

A statistical study of the four maxillary incisor teeth individually and the mean for these four teeth is depicted in Table 2. The

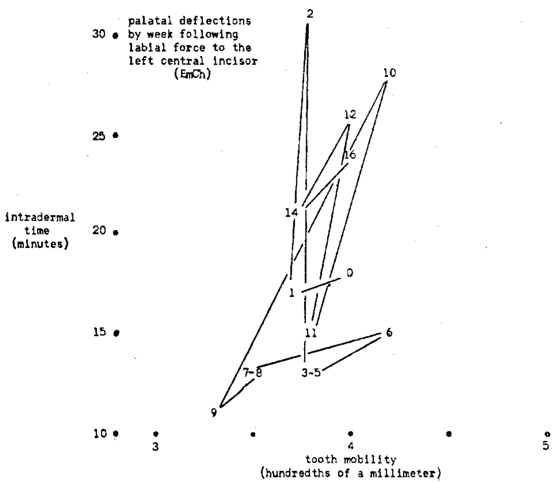

Fig. 16. The palatal deflections, by week, following a labial force of 500 grams to the left central incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

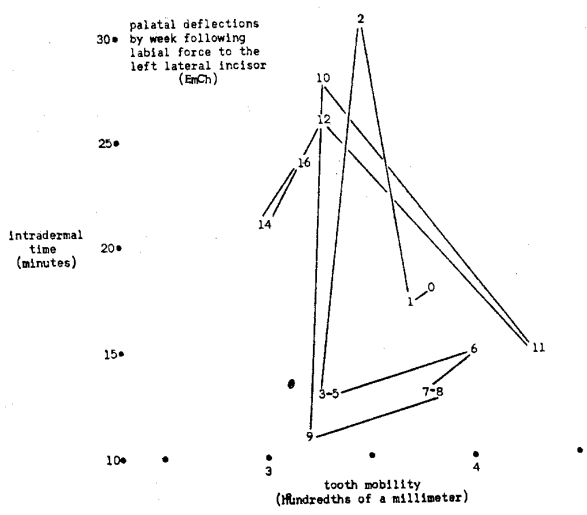

Fig. 17. The palatal deflections, by week, following a labial force of 500 grams to the left lateral incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One signifies the tooth mobility after one week of ascorbic acid supplementation.

chart shows that, during the first week of ascorbic acid supplementation, there were *no statistically* significant changes in any of these four teeth or in the average for the four teeth collectively as evidenced by a P ranging from greater than .20 to .50. The evidence is available, but not included here, to show that at no time during the sixteen-week period were there *statistically* significant mobility changes in any of these four teeth.

TABLE 2

Comparison of the significance of palatal deflections initially and after one week of ascorbic acid supplementation

Case Report No. 2 (EmCh)

tooth number(s)	r	t	P
7	+.218	.447	.50
8	—.577	1.483	>.20
9	+.353	1.413	>.40
10	+.333	.755	>.40
7, 8, 9, 10	+.025	.177	.50

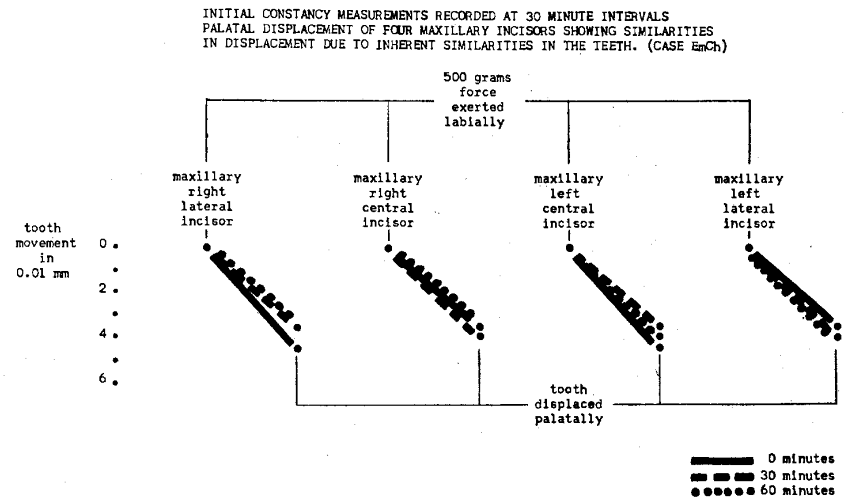

Fig. 18. Initial constancy measurements recorded at 30 minute intervals showing the palatal displacement of the four maxillary incisor teeth due to inherent similarities.

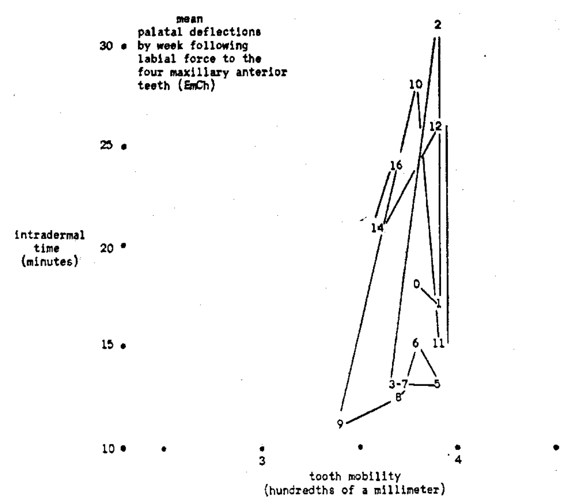

Fig. 19. The mean palatal deflections, by week, following a labial force of 500 grams to the four maxillary incisor teeth individually. "Zero" represents the average tooth mobility at the initial visit. "One" signifies the mean tooth mobility after one week of vitamin supplementation.

Case Report No. 3

JoMa is a 25 year-old dental practitioner in presumably good health. The personal and family medical histories are noncontributory. Figures 20 and 21 show the clinical and roentgenographic picture of the maxillary anterior teeth and associated periodontal structures. The general statement can be made that they appear "normal" in all respects. Figure 22 shows the fasting plasma ascorbic acid values and intradermal scores at each of the visits. It is clear from this chart that the initial fasting plasma ascorbic acid level was .31 mgm. percent and the initial fasting intradermal test time 34 minutes. According to known standards, these values are indicative of an *inadequate* ascorbic acid status.

It is evident from Fig. 22 that, after one week on a 1000 mgm. per day regime of ascorbic acid, the fasting plasma ascorbic acid level increased to 1.56 mgm. percent. This means that the fasting plasma ascorbic acid level increased approximately 500 percent. At the same time, during this first week with vitamin support, the intradermal time decreased from 34 to 14 minutes. This is a reduction of approximately 60 percent. Figure 22 shows that there are minor fluctua-

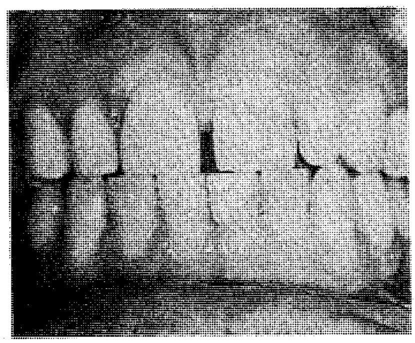

Fig. 20. The clinical picture of the anterior teeth and associated periodontal structures of a 25 year-old, presumably healthy, individual.

Fig. 21. The roentgenographic picture of the maxillary anterior teeth and associated periodontal structures of a 25 year-old, presumably healthy, individual.

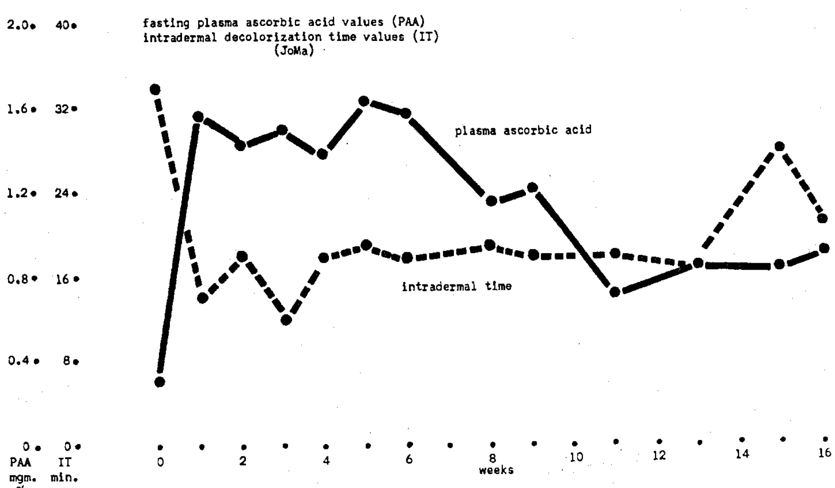

Fig. 22. A sixteen-week record of the fasting plasma ascorbic acid levels and intradermal times. The findings at "zero" week of .31 mgm. percent and 34 minutes are indicative of an inadequate ascorbic acid status. The determinations at the first through eighth weeks show the values during the period when the subject took 1000 grams of ascorbic acid daily. No vitamin supplementation was given during the last eight weeks.

tions in both the fasting plasma ascorbic acid levels and the intradermal test scores. The fasting plasma ascorbic acid level remained very high throughout the eight weeks with ascorbic acid supplementation. It decreased somewhat during the last eight-week period. However, the fasting plasma ascorbic acid levels never returned to the original value of .31 mgm. percent. Interestingly enough, once the intradermal time decreased, it re-

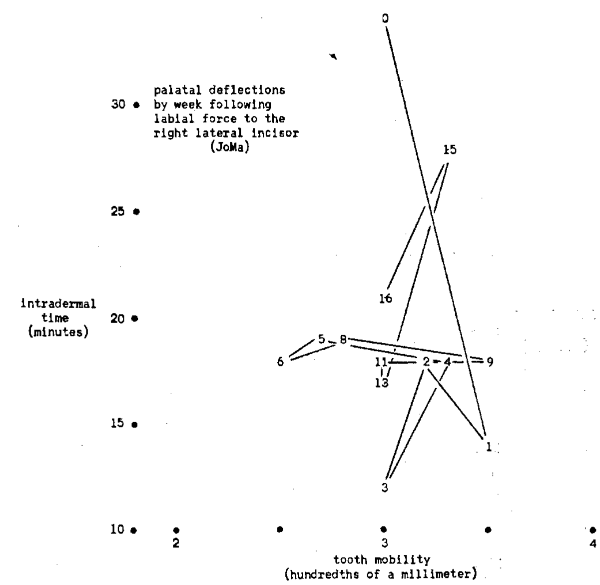

Fig. 23. The palatal deflections, by week, following a labial force of 500 grams to the right lateral incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

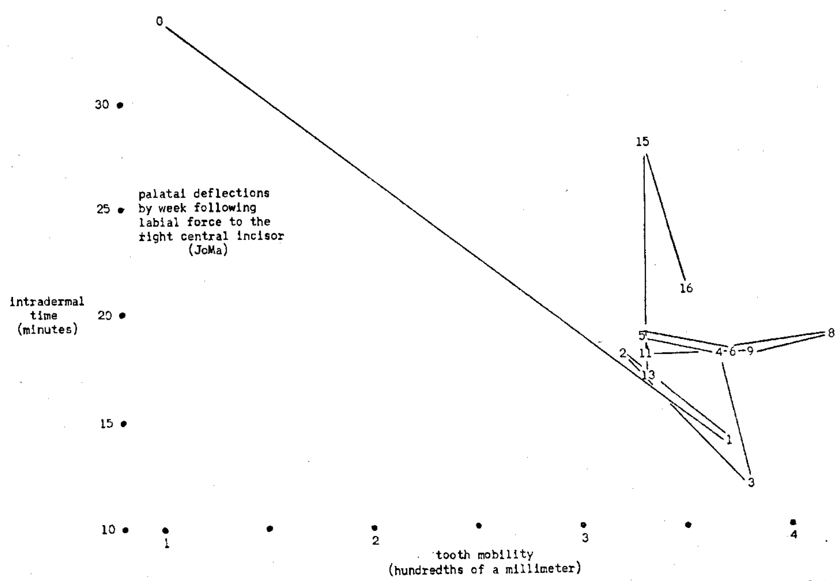

Fig. 24. The palatal deflections, by week, following a labial force of 500 grams to the right central incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

mained so throughout the period of supplementation and even throughout most of the second eight-week interval. Only during the last four weeks did the intradermal time begin to increase and approach the initial level of 34 minutes as evidenced by a final skin time of 21 minutes.

Figures 23-26 show the tooth mobility

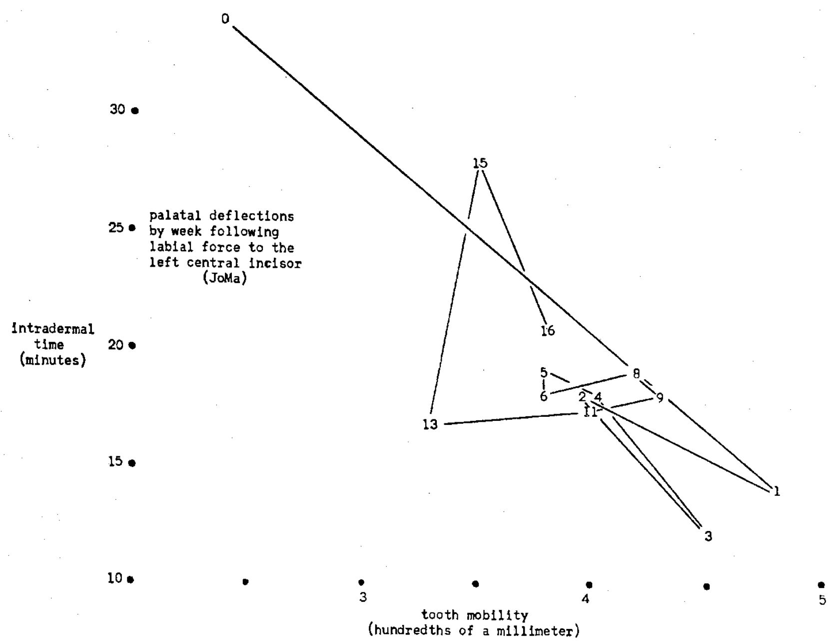

Fig. 25. The palatal deflections, by week, following a labial force of 500 grams to the left central incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

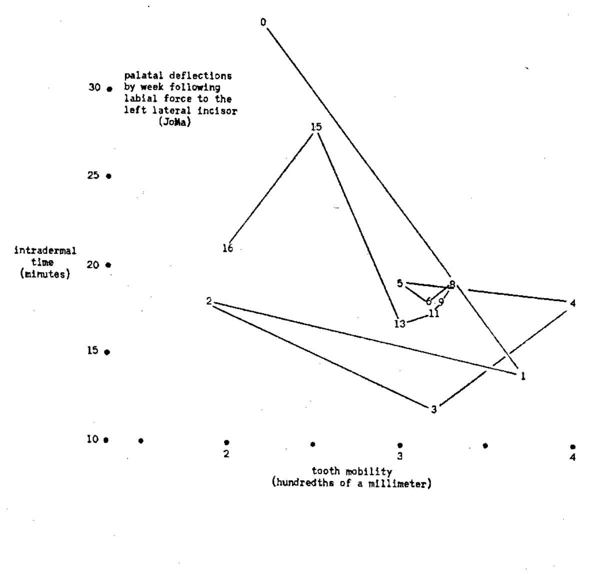

Fig. 26. The palatal deflections, by week, following a labial force of 500 grams to the left lateral incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

scores, on the basis of 156 individual measurements, for the four maxillary incisor teeth (No. 7, 8, 9, 10) prior to the start of vitamin therapy, during the eight weeks with ascorbic acid supplementation, and for the eight weeks without medication.

amination of these charts also shows that, after the first week with supplementation, the variations in the different teeth were small. *Finally*, an examination of these charts discloses that, after the vitamin therapy was discontinued and the intradermal time began

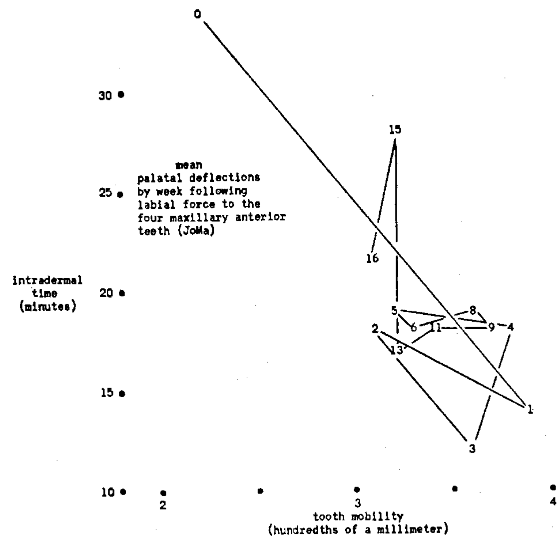

Fig. 27. The mean palatal deflections, by week, following a labial force of 500 grams to the four maxillary incisor teeth individually. "Zero" represents the average tooth mobility at the initial visit. "One" signifies the mean tooth mobility after one week of vitamin supplementation.

Several observations are of interest. *First,* the initial tooth mobility differed among these four teeth. This is quite understandable since the teeth vary in size, position, and the rotation center is obviously quite different (Figs. 20 and 21). *Secondly,* it is clear that during the very first week with ascorbic acid supplementation, considerable change in tooth mobility occurred. A comparison of the initial and first week supplementation findings discloses that, whereas the right lateral incisor varied only a matter of .005 mm. during this first week interval (Fig. 23), the other three teeth changed .032 (Fig. 24), .023 (Fig. 25), and .017 (Fig. 26) mm. An ex-

to lengthen again, some of the teeth started to return to the original tooth mobility range observed at the start of the study. Figure 27 depicts the pattern for the composite of the four maxillary incisor teeth. Again, it appears that the overall variations in tooth mobility and intradermal test time for these four teeth individually are consistent with the average for the four teeth collectively.

A statistical study of these four teeth individually and the mean for the four maxillary incisor teeth is depicted in Table 3. The chart shows that, during the first week of ascorbic acid supplementation, there were *statistically* significant changes in all of the teeth, except the right lateral incisor, as evidenced by a P of greater than .10, less than .005, less than .025, and less than .05 for the right lateral, central, left central, and lateral incisor teeth respectively. Table 3 also shows a P of less than .001 for the four teeth as a group. The evidence is available, but not included here, to show that for the rest of the supplementation period at no time were there *statistically* significant mobility changes in any of the four teeth.

A comparison of the initial tooth mobility

TABLE 3

Comparison of the significance of palatal deflections initially and after one week of ascorbic acid supplementation

Case Report No. 3 (JoMa)

tooth number(s)	r	t	P
7	—.650	1.710	>.10
8	—.970	7.980	<.005
9	—.876	3.632	<.025
10	—.846	3.173	<.05
7, 8, 9, 10	—.750	5.318	<.001

changes (Table 3) with those at the eighth week (the last week of ascorbic acid supplementation) and the sixteenth week (the last week of no vitamin support) discloses the fact that tooth mobility variations are approaching those noted at the start of the experiment (Table 4). This is underscored by the following observations: (1) during the first week, the right lateral incisor was not significantly influenced by the vitamin addition (Table 3), (2) the right lateral incisor was also not seriously influenced when vitamin therapy was discontinued (Table 4), (3) the two teeth *most influenced* during the first week with ascorbic acid support were the right central and left central incisors (Table 3), (4) these same teeth were not seriously influenced when the vitamin regime was discontinued (Table 4), (5) the left lateral incisor was *least significantly* altered at the start of therapy (Table 3), and (6) this tooth was significantly changed when the vitamin was discontinued (Table 4).

TABLE 4

Comparison of the significance of palatal deflections between the eighth week (the end of vitamin supplementation) and the sixteenth week (the end of no vitamin supplementation)

Case Report No. 3 (JoMa)

tooth number(s)	r	t	P
7	+.446	0.997	>.40
8	—.705	1.988	>.10
9	—.705	1.988	>.10
10	—.893	3.968	<.025
7, 8, 9, 10	—.426	2.208	<.05

Case Report No. 4

JoDu is a 28 year-old dental practitioner in presumably good health. The past and family medical histories are noncontributory. The only dental history of significance is that this individual underwent orthodontic therapy during the ages of 21 to 23. Originally, the maxillary incisor teeth were lingual to those in the mandibular arch. During this two year orthodontic period, these teeth were moved labially into a more acceptable relationship. The left lateral incisor underwent the least while the right lateral incisor underwent the greatest orthodontic movement. Figures 28 and 29 show the clinical and roentgenographic picture of the maxillary anterior teeth and associated periodontal structures. The general statement can be made that they appear "normal" in all respects. Figure 30 shows the fasting plasma ascorbic acid values and intradermal scores at each of the visits. It is clear from this chart that the initial fasting plasma ascorbic acid level was .79 mgm. percent and the initial fasting intradermal test time 30.5 minutes. According to presently accepted standards, a fasting plasma ascorbic acid level of this magnitude is regarded by some individuals as being either a *low normal* value or representative of a *marginal* ascorbic acid deficiency state. According to all known intradermal standards, 30.5 minutes is indicative of a *subclinical* vitamin C deficiency.

An examination of Fig. 30 shows that the intradermal time decreased from 30.5 minutes to 15 minutes during the eight-week

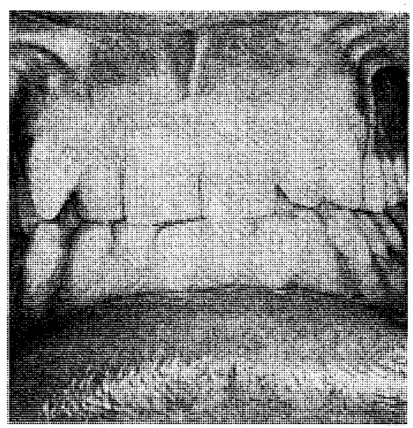

Fig. 28. The clinical picture of the anterior teeth and associated periodontal structures of a 28 year-old, presumably healthy, individual.

Fig. 29. The roentgenographic picture of the maxillary anterior teeth and associated periodontal structures of a 28 year-old, presumably healthy, individual.

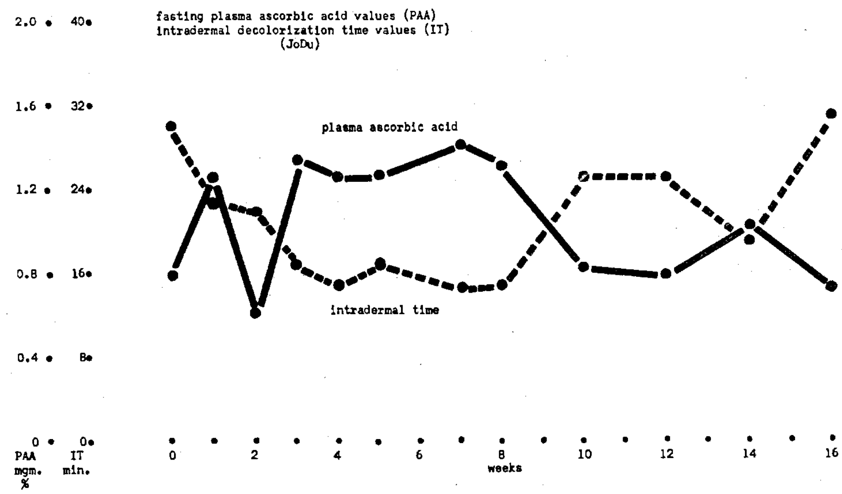

Fig. 30 A sixteen-week record of the fasting plasma ascorbic acid levels and intradermal times. The findings at "zero" week of .79 mgm. percent and 30.5 minutes are indicative of an inadequate ascorbic acid status. The determinations at the first through eighth weeks show the values during the period when the subject took 1000 grams of ascorbic acid daily. No vitamin support was given during the last eight weeks.

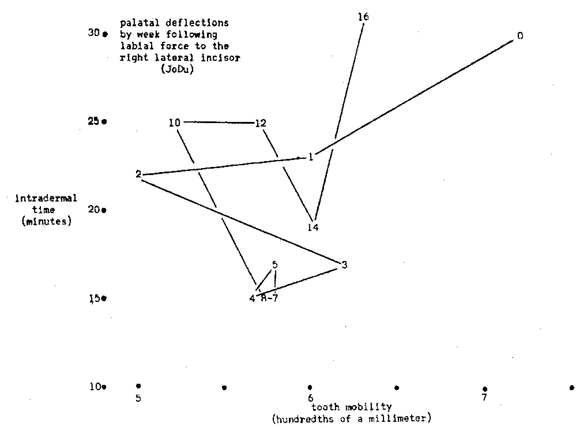

Fig. 31. The palatal deflections, by week, following a labial force of 500 grams to the right lateral incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

supplementation period. More specifically, the intradermal time continued to decrease during the first four weeks. Mention should be made that the intradermal time reached known acceptable levels far more slowly in this individual than Case Report No. 3. After vitamin therapy was discontinued, the intradermal decolorization time increased and the final value was essentially that observed at the start of the experiment.

Figures 31-34 show the tooth mobility scores, on the basis of 144 individual measurements, for the four maxillary incisor teeth (No. 7, 8, 9, 10) prior to the start of vitamin therapy, during the eight weeks with ascorbic acid supplementation, and for the eight weeks without medication. Several observations are of interest. *First,* the initial tooth mobility differed among the four maxillary incisor teeth (Fig. 35). This is unquestionably, in part, the result of orthodontic treatment as evidenced by the fact that tooth mobility is least in the left lateral incisor (the tooth which had undergone the *least* orthodontic therapy) and *greatest* in the right lateral incisor (the tooth which had been subjected to the greatest movement). No doubt, tooth mobility variations are in part a function of tooth size, position, and rotation center as previously discussed in the other subjects. *Secondly*, the evidence suggests that, from week to week, tooth mobility varied in the same tooth and different teeth. However, the greatest change in tooth mobility seemed to occur during the first week of supplementation in all of the teeth except the left lateral incisor — the one which had undergone the least orthodontic movement. Whereas the left lateral incisor *increased* in tooth mobility from .030 to .035 mm. (.005mm.) during this first week interval (Fig. 31), the other three teeth *decreased* in tooth mobility .012 (Fig. 32), 019 (Fig. 33), and .015 mm. (Fig. 34) respectively. Interestingly enough, and quite unlike the preceding case, additional decreases in

TABLE 5

Comparison of the significance of palatal deflections initially and after one week of ascorbic acid supplementation

Case Report No. 4 (JoDu)

tooth number(s)	r	t	P
7	+.742	2.213	>.05
8	+.968	7.700	<.005
9	+.616	1.564	>.10
10	—.654	1.729	>.10
7, 8, 9, 10	+.310	1.529	>.10

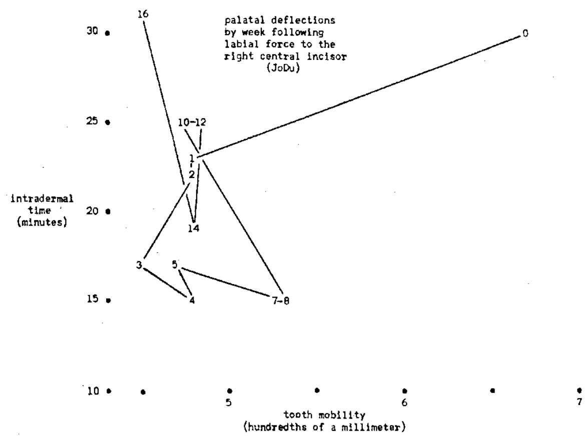

Fig. 32. The palatal deflections, by week, following a labial force of 500 grams to the right central incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

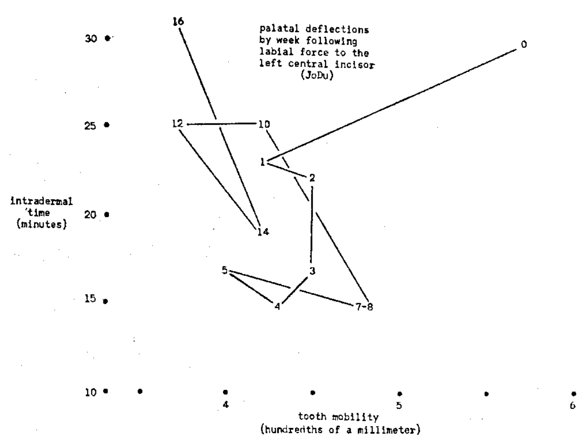

Fig. 33. The palatal deflections, by week, following a labial force of 500 grams to the left central incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

tooth mobility occurred in some of the teeth during the second week of supplementation. This is particularly evident in the right lateral incisor (Fig. 31) which, during the second week on vitamin therapy, decreased in tooth mobility another .01 mm. *Finally*, an examination of Figs. 31-34 shows two additional very interesting changes. (1) a comparison of the tooth mobility changes at the eighth week (the last week of supple-

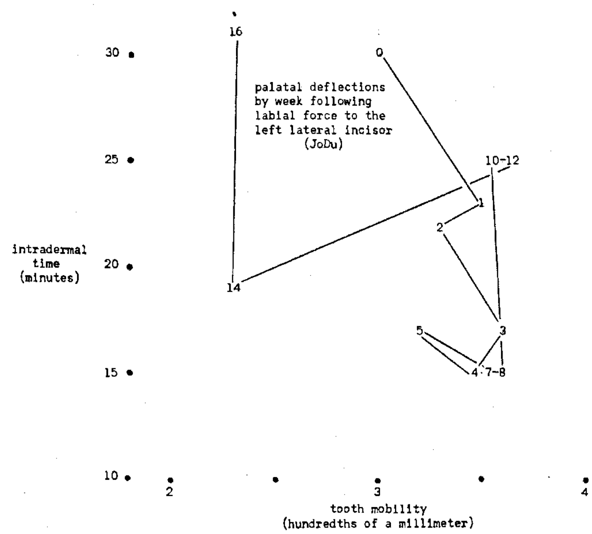

Fig. 34. The palatal deflections, by week, following a labial force of 500 grams to the left lateral incisor tooth. "Zero" represents the tooth mobility at the initial visit. "One" signifies the tooth mobility after one week of ascorbic acid supplementation.

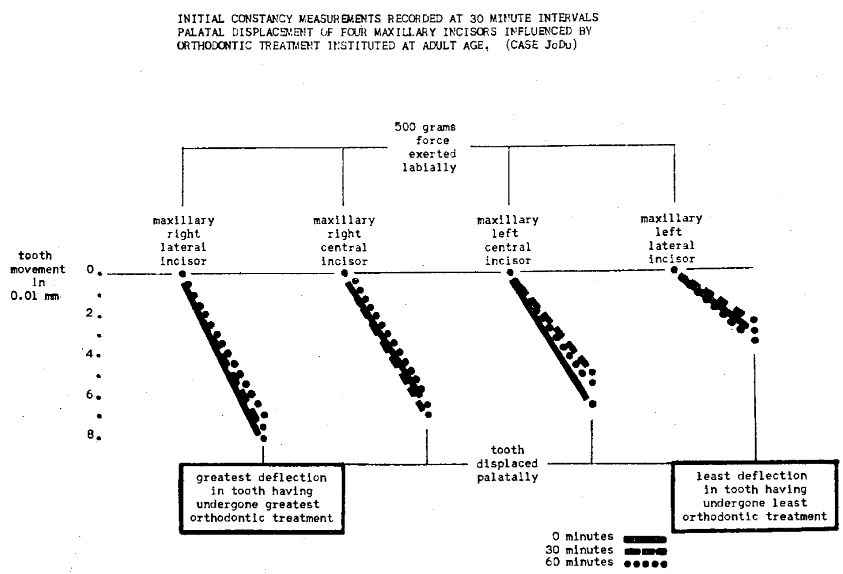

Fig. 35. Initial constancy measurements recorded at 30 minute intervals showing the palatal displacement of the four maxillary incisor teeth as a result of orthodontic treatment instituted during adulthood.

mentation) with the sixteenth week (the last week without supplementation) shows that some of the teeth once again demonstrated considerable tooth mobility, and (2) that, generally, the teeth all showed less tooth mobility at the end of the experiment as contrasted with the initial observations.

Table 6, (a comparison of tooth mobility at the first and second weeks of supplementation) reveals *no statistically* significant variations in tooth mobility. However, Table 7, a comparison of the initial values with those obtained after two weeks of supplementation, now shows that both the right

TABLE 6

Comparison of the significance of palatal deflections between the first and second weeks of ascorbic acid supplementation

Case Report No. 4 (JoDu)

tooth number(s)	r	t	P
7	+.655	1.734	>.10
8	0	0	.50
9	—.700	1.961	>.10
10	+.446	.977	>.20
7, 8, 9, 10	+.120	.567	.50

TABLE 7

Comparison of the significance of palatal deflections initially and after two weeks of ascorbic acid supplementation

Case Report No. 4 (JoDu)

tooth number(s)	r	t	P
7	+.956	6.520	<.005
8	+.967	7.586	<.005
9	+.497	1.146	>.20
10	—.445	.994	>.20
7, 8, 9, 10	+.394	1.891	>.05

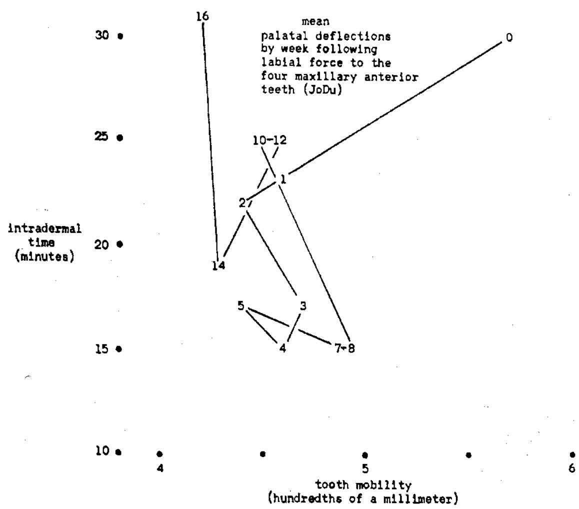

Fig. 36. The mean palatal deflections, by week, following a labial force of 500 grams to the four maxillary incisor teeth individually. "Zero" represents the average tooth mobility at the initial visit. "One" signifies the mean tooth mobility after one week of vitamin supplementation.

Figure 36 depicts the pattern for the composite of the four maxillary incisor teeth. Again, it appears that the overall mean variations in tooth mobility and intradermal test time for these four teeth individually are consistent with the average for the four teeth collectively.

A statistical study of the individual teeth and the mean for the four maxillary incisor teeth, during the first week of ascorbic acid supplementation, is shown in Table 5. The chart points out that, during the first week of ascorbic acid supplementation, there were *statistically* significant changes in tooth mobility only in the right central incisor as evidenced by a P less than .005. A study of

TABLE 8

Comparison of the significance of palatal deflections between the eighth week (the end of vitamin therapy) and the sixteenth week (the end of no vitamin supplementation)

Case Report No. 4 (JoDu)

tooth number(s)	r	t	P
7	+.468	1.059	>.20
8	—.928	4.981	<.01
9	—.927	4.943	<.01
10	—.868	3.496	<.025
7, 8, 9, 10	—.260	2.142	<.05

lateral and central incisors decreased in tooth mobility sufficiently to show a P less than .005. An examination of Table 8, a comparison of the tooth mobility changes at the eighth week (the last week of ascorbic acid supplementation) and the sixteenth week (the last week of no vitamin support) discloses the fact that tooth mobility variations are approaching those observed at the start of the experiment in Case Report No. 3.

Discussion

For purposes of simplicity, the discussion will be divided into three phases: (1) the initial findings, (2) the supplementation period, and (3) the no-supplementation period.

Initial Findings

Included in this report are the data for four subjects. According to all known standards, two of the individuals (ArJi and EmCh) demonstrate: (1) no clinical nor laboratorial evidence of an ascorbic acid deficiency, and (2) a "physiologic" range of tooth mobility. The other two subjects (JoMa and JoDu) demonstrate: (1) no clinical evidence but reasonable laboratory proof of a *subclinical* vitamin deficiency. and (2) a "pathologic" range of *subclinical* tooth mobility. The latter group differ in that one subject (JoDu) had orthodontic therapy during adulthood while the other (JoMa) had not.

The subclinically deficient individual sans orthodontic therapy (JoMa) showed initial tooth mobility changes of a magnitude *less than* that observed in the normal subjects. In other words, the teeth seem to be abnormally "tight". The subclinically deficient subject with orthodontic therapy (JoDu) showed initial tooth mobility changes of a magnitude *greater than* that observed in the normal subjects. In other words, the teeth seemed to be abnormally "loose".

The Supplementation Period

During the eight week period with 1000 mgm. of ascorbic acid daily, the two subjects without a vitamin deficiency had two features in common: (1) the fasting plasma ascorbic acid level and intradermal times varied little, and (2) tooth mobility changed minimally. These observations are quite understandable since these two subjects did not need this type of supplementation. The variations which did take place can be explained on the basis of: (1) variations in tooth size, shape, position, and rotation center, (2) the inherent errors in periodontometry, and (3) intercurrent stress as evidenced by the occasional episodes of infection and migrainous attacks.

During the eight-week period with massive ascorbic acid supplementation, the two subjects with a vitamin deficiency had four features in common: (1) the fasting plasma ascorbic acid levels increased considerably to levels generally regarded as normal, (2) the fasting intradermal decolorization test times decreased markedly to levels usually recognized as normal, (3) the range of tooth mobility changed considerably, and (4) the most significant mobility variations occurred during the first or second week of vitamin support. True enough, there were differences between the two subjects explainable on the basis of: (1) variations in tooth size, shape, position, and rotation center, (2) the inherent errors of periodontometry, and (3) the presence in one and absence in the other of orthodontic movement. In one subject the teeth "loosened" while in the other subject the teeth "tightened,,'

No-Supplementation Period

During the last two weeks without ascorbic acid support, the two subjects without a vitamin deficiency had two features in common: (1) the fasting plasma ascorbic acid levels and the intradermal times varied little, and (2) tooth mobility changed minimally. These observations are quite understandable since these two subjects did not require supplementation in the first place. The variations which did take place can be explained on the basis of: (1) variations in tooth size, shape, position, and rotation center, and (2) the inherent errors in periodontometry.

During the eight-week period without massive ascorbic acid supplementation, the two subjects with a vitamin deficiency had four features in common: (1) the fasting plasma ascorbic acid levels decreased, (2) the fasting intradermal decolorization test times increased, (3) the range of tooth mobility changed, and (4) the most significant alterations in the no-supplementation period occurred during the last weeks. True enough, there were differences between the two subjects: (1) variations in tooth size, shape, position, and rotation centers of the teeth, (2) inherent errors in periodontometry, and (3) the presence in one and absence in the other of orthodontic treatment.

Conclusions

1. The literature is replete with description of *clinical* scurvy. The teeth become loose and exfoliate in the classically scorbutic patient.

2. There is general agreement that classical scurvy is rare.

3. Only fragmentary information is available regarding so-called *subclinical* scurvy.

4. Considerable data are available regarding *clinical* tooth mobility.

5. Far less information is available concerning *subclinical* tooth mobility.

6. There is no reported study of the relationship or lack of relationship between *subclinical* scurvy and *subclinical* tooth mobility.

7. A group of clinically healthy subjects was studied, small in number (four subjects) but extensive in depth (four-month study), in terms of *subclinical* ascorbic acid status and *subclinical* tooth mobility.

8. Two of the subjects showed neither clinical nor laboratory evidence of an ascorbic acid deficiency. These same two subjects demonstrated a physiologic range of tooth mobility.

9. The other two subjects showed no *clinical* evidence of a vitamin deficiency but did demonstrate *laboratory* proof of a *subclinical* ascorbic acid deficiency. These two subjects differed in that only one had undergone orthodontic therapy during adulthood.

10. Initially, the subject without orthodontic treatment had teeth with only small ranges of tooth mobility. After one week on a massive ascorbic acid regime, the teeth "loosened" and the range approached that of the two healthy subjects.

11. The subject with orthodontic treatment had teeth with a large range of tooth mobility initially. After two weeks on a massive ascorbic acid regime, the teeth "tightened" and the range approached that of the healthy subjects.

12. When vitamin therapy was discontinued, the vitamin levels appeared to return to their original values in the last two subjects.

13. Interestingly enough, the tooth mobility trend also seemed to suggest that their patterns were reversing to that observed at the beginning of the experiment.

Acknowledgments

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